PROCEEDINGS OF THE TWENTIETH ANNIVERSARY SEMINAR ON DEVELOPMENT OF FISH PRODUCTS IN SOUTHEAST ASIA

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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, Malaysia, Philippines, Singapore and Thailand. SEAFDEC has three Departments, namely, the Aquaculture Department in the Philippines; the Training Department in Thailand; and the Marine Fisheries Research Department in Singapore.

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CONTENTS

Foreword

SEAFDEC was formed twenty years ago in 1967 as a regional technical body to assist in the accelerated development of fisheries in Southeast Asia at a time when the fisheries resources in the continental shelf had not been fully exploited. The founding countries were Japan, Singapore and Thailand. Today, SEAFDEC has five member countries which include Malaysia and the Philippines and the three founding countries. The Agreement for the establishment of SEAFDEC required member countries to decide after ten years whether SEAFDEC should continue. At the 10th Council Meeting of SEAFDEC in Tokyo in 1976, member countries recognising the role of SEAFDEC in the development of fisheries voted unanimously for the continuation of the Center. Fisheries production has more than doubled over the past 20 years. SEAFDEC has played a significant role in this.

SEAFDEC has made remarkable progress since its inception. The organisation started with only two departments and a Secretariat, the Marine Fisheries Research Department (MFRD) in Singapore and the Training Department and Secretariat in Thailand. In 1973, SEAFDEC expanded with the establishment of a third arm, the Aquaculture Department in the Philippines.

The development of SEAFDEC in the last 20 years has shown that all the member countries are able to work together for the mutual benefit of fisheries development in the region. SEAFDEC's three departments cover almost the whole range of fisheries activities from production to processing of fish. In pursuit of common objectives in research and development and transfer of technology, they have not only advanced our knowledge in fisheries science but have also directly benefited fishermen, fish farmers and fish processors. Between them the three Departments have trained over 5,000 persons from the public and private sectors in the region, as well as from some other parts of the world. Some of these ex-trainees now play important and influential roles in fisheries development in their own countries and in the region.

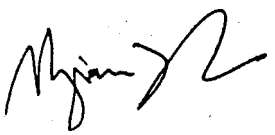
With rapid growth come new problems. As fisheries production increases in the region, post-harvest handling, preservation, processing, packaging, transportation and marketing methods must also be developed to take care of this increased volume.

Recognising these post-harvest needs, and at the request of Singapore, the Japanese Government in 1976 dispatched a team of experts to the SEAFDEC member countries to study the situation and to recommend a programme covering this aspect of fisheries development. The team subsequently supported the establishment of a post-harvest technology programme in MFRD. This team was led by Dr Keishi Amano, an expert in the field of fisheries post-harvest technology and formerly President of the Tokyo University of Fisheries. Dr Amano not only initiated the programme but played a major role in setting it up through his personal involvement over the years.

The Japanese Government also provided the necessary experts and support to expand MFRD's activities and to gradually establish post-harvest technology as its primary focus. The Singapore Government, through its Primary Production Department is also fully committed to this programme. To further expand the capabilities of MFRD, the Primary Production Department will be constructing a new product development and packaging laboratory for MFRD. These facilities are expectd to be completed in the second half of 1988.

Although the post-harvest technology programme was started comparatively recently, I am pleased to note that MFRD has been remarkably successful in its search for ways to better utilise trawl by-catch for human consumption. It has also expanded its activities to include other areas in which I wish it equal success.

The holding of this Seminar on the Development of Fish Products in Southeast Asia is yet another mile-stone of MFRD's activities. The publication of these proceedings will additionally serve to mark SEAFDEC's 20th Anniversary. I am confident that this document will not only provide a useful record of post-harvest technology progress in the past 20 years, but will contribute to its further development in the region.



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Introduction

The Seminar on the Development of Fish Products in Southeast Asia was held to commemorate the 20th Anniversary of the foundation of SEAFDEC, at the invitation of the Center's Marine Fisheries Research Department. It was attended by representatives of SEAFDEC's Member Countries: Japan, Malaysia, Philippines, Singapore and Thailand and from Indonesia, the Canadian International Development Agency and from SEAFDEC.

The purpose was to provide a forum for an updated exchange of information on the status of post harvest technology, to discuss common problems, to share experience and to make recommendations for action.

Following a keynote lecture by Dr K Amano, President of the Japanese Society of Food Science and Technology, the Seminar proceeded on the following lines. Each country presented a Country Report on the status of fish post harvest technology and a more specific Case History covering a specific improvement in that country. Resource persons delivered additional papers on selected topics related to the interest of the Seminar. A separate discussion followed the delivery of each paper. These were followed by two general discussions of the Country Reports and of the Case Hisotries.

The final item on the agenda was a plenary discussion of problems followed by the tabling of recommendations for action.

Key-note Lecture

Problems of Post-harvest Technology in Southeast Asia

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Fresh Fish Handling

The improvement of fresh fish handling remains the most important fisheries task facing the countries of the region.

Nobody would deny that good keeping quality of wet fish can be attained only by a quick chilling on board immediately after catching. But the need to chill fish aboard is still far from the thoughts of fishermen who are quite enthusiastic about the quality of the catch they haul.

There is a clear need for technologists in charge of fisheries development to demonstrate the advantage of ice through extension activities.

Research by MFRD and by Tropical Products Institute (U.K.) indicates that well-chilled wet fish from tropical waters can tolerate a month-long storage in the iced condition. It is interesting to note that fish from warm waters may be better preserved by chilling than those from temperate waters.

Information of this kind should be actively disseminated to fishermen and fishing industries who have long been accustomed to handle their catches without a single piece of ice aboard.

Fishermen should also be urged to check the residual amount of ice in the fish hold during the voyage home and in the vehicles that transport fish from the landing site to the point of marketing to ensure that the fish remain chilled. New ice should be added if necessary.

If commercially feasible, installation of mechanical refrigeration systems in fishing boat holds and in lorries should be considered. These facilities will extend the range of the vehicles allowing wet fish to reach remote places where new markets for fresh fish could be created.

Promotion of sales of wet fish may be possible, particularly in inland areas where demand may well exist. On the other hand, it should be remembered that people accustomed to freshwater fish are sometimes prejudiced against fish of marine origin or iced fish. Patient extension work may be required to introduce a new eating habit.

A major obstacle to the chilling of wet fish is non-availability of reasonably-priced ice. In some developing countries, one ton of block ice may cost about US$50. Ice production should be encouraged not only for fish chilling but for the preservation of vegetables and other perishable items.

A related issue is live fish transportation. A remarkable growth has been seen in inland fisheries and aquaculture for species of fish reared in a brackish or marine environment.

Traditional Products

Many types of traditional fish products may be seen in the region. Long-established food items such as dried, salt-dried, boiled, salted, smoked and fermented fish play an important part in the diet of the population.

Processing of fish by traditional methods is usually a cottage industry carried out with restricted facilities, limited investment in equipment, and little hired labour.

It should be noted that small-scale production can result in better quality control. Quite often, in smaller operations, the owner of the firm serves as the chief technologist of processing and accumulates considerable experience in a specific product. So, it may be suggested that an operation of this kind should not necessarily be enlarged even when more production is required by the market — not if the firm wants to retain its reputation for good quality.

The need to upgrade the quality of these traditional fish products must be seriously considered.

The most important factor in determining product quality is the character of the product and the freshness of raw material. Since chemical composition of fish muscle changes with the season, technologists in charge should always be aware of delicate changes in the nature of fish as well as the progress of spoilage.

For the production of dried fish, an artificial drier may be useful-particularly in the rainy season. Operation of these driers should be carried out with close attention to the quality of the finished product.

Smoked fish is another popular product in hot and humid zones. Smoking is an effective way to protect wet fish from deterioration, since fish can be dehydrated concurrently in the smoking kiln. This form of processing has been used in temperate areas like Europe and North America since ancient time and the products have contributed to the nutrition of the people.

Since smoking has an antioxidative effect for oil in fish, it may be a good way to extend the shelf life of fish — in particular fatty fish. Otherwise these fish will readily develop rancidity.

Various types of smoking oven have been reported. Sometimes, a less sophisticated oven design is more practical and convenient to operate. The "Chorkor" named after a village in Ghana and developed by a woman of that country is a simple device that can smoke about 240 kg in a single operation.

Fermented products such as fish sauce or fish paste, have been widely consumed in the region and some is being exported. Techniques for shortening the fermentation period have occasionally been tried but there have been no commercial applications. The conventional technique is to hold the mixture of fish and common salt in the tank for about one year.

Fish sauce may be one product which needs quality standards and inspection, since as a liquid form, it can easily be adulterated. In some areas, a flavouring agent such as MSG is incorporated into the sauce. This may enhance the taste of the product, but from the view of good manufacturing practice, it may be condemned as an adulterated product.

Fish Products for Export

Southeast Asian countries export fish products not only to western countries, but to their neighbour nations.

For example, fresh fish trade has long been established between Thailand, Malaysia, Indonesia and Singapore. In addition, varieties of conventional products, such as dried, salted, smoked and fermented fish are distributed through foreign trade.

Increasing quantities of frozen items, like shrimp, squid, bivalves and surimi are being shipped to Japan, U.S. and European countries.

Expanded exports may be desirable for the developing countries in terms of the earning of foreign exchange. But, it should be noted how much emphasis has been given to this part of market.

In an article prepared by FAO experts, certain developing countries are reported to have built export trade in fish and fish products valued at around US$500 million a year. At the same time these very countries are importing fish products at a cost over US$1000 million annually.

If these figures reflect a substantial deficit in domestic fish supplies, then a drive to expand export markets should be regarded as a questionable policy.

The story just related applies to the government policy of the countries involved and I must say at this point that I am reluctant to draw from it any general conclusion; there may well be cases in which a food policy of self-sufficiency may not be practical.

However, when it comes to the topic of how to feed the people of country, self-sufficiency must be a high priority policy goal to secure the stability of the peoples' life and the independence of the nation. It should be pursued wherever natural resources are available in the form of agriculture, animal husbandry and fisheries products.

While development of domestic marketing just cannot take place on a scale which will make any real impact, the export trade is easier and more attractive to products and processors. This is because most export industries are based on joint ventures and because major aspects of operation are often conducted by experienced technologists from buyers' association.

This may also lead to quality control and quality standards being developed for export products using criteria set by the importing countries.

Presumably conduct of quality control of this type might contribute to some upgrading of products for domestic market but that depends on how actively the government staffs concerned with quality control exchange information with the export business people.

It is the government, which must take the lead in improving the various aspects of the industry's operation. These include technological improvement, market stimulation (by providing facilities for landing), ice making, distribution and so on. It is often observed that governments usually say fish marketing is better left in the hands of the existing private sector. The private sector, on the other hand, tends to be reluctant to engage in domestic marketing unless it can be assured a profitable outcome.

The conservation of energy is becoming essential to the world economy, since it has been estimated that fossil fuels will not be available in the coming century at the present level of consumption. In other words, we have to provide certain alternative energy sources for our survival.

Utilization of Available Resources for Direct Human Consumption

The term "available resources" here cited means fish varieties hitherto underutilized because of difficulties in making from them, edible forms for human consumption.

Good information about the raw material in question should be assembled or investigated prior to new product development.

Generally speaking the work of inventing a new product from fish previously regarded useless, cannot usually be undertaken by private industry, except by a few firms in which the technologist can engage in product development. Biochemical or chemical information about raw material of any new species of fish is indispensable to technologists in developing a new technique. Perhaps, research of this type can only be undertaken on governmental basis or by international organization.

The importance of a basic knowledge of raw material may readily be understood when one reflects on the quality difference in wheat species and types of products prepared thereof.

A new engineering development may also be needed, for without the invention of appropriate machinery, separation of meat portion from small pelagic fish will be almost impossible.

Selection of the product form as well as the nature of finished product will be important and difficult to decide. Consumer preference are conservative in many countries and it may be impossible to introduce a completely new product no one has ever eaten before.

Therefore, it is useful to remember that the product prepared from available resources does not have to be literally "new". In other words a product that is conventional in one country can be new in another.

Surimi in frozen form, produced on an industrial scale is an example of a new product invented in Japan about 20 years ago. But long before that fresh surimi had been prepared every morning at more than 3000 plants of *kamaboko* manufacturers.

Food habits have changed throughout human history. This reminds us to expect introduction of new product when social and economical environment permits.

For example, growth of wheat imports has been remarkably rapid in the tropical countries, where temperate crops like wheat have not traditionally been grown, expect on elevated land. But, wheat products, usually bread, have become a basic food staple for many people.

The lesson is that the possibility of putting new fish products into the markets of the region should not be ignored.

In this context, we should seek out potential resources and set out to solve the problems by the application of technology or by market introduction. Survey should be undertaken of all countries concerned with such problems.

The Role of Post-harvest Technologists

The role of the technologist in charge of product improvement in the fish and fish product industries is one of great importance.

It may often not be practical to keep such a technologist on the staff of a private firm. So we must focus here on the technologist working for government.

The expert needed should be a multi-talented technologist who can handle product quality improvement and also advise management of industry.

People with these qualifications may be hard to find at the moment but government should try to nurture them in order to plan and expand product development in the fisheries industries.

This could be done, so to speak, through self-training. Technologists who take up these positions will attain the capability on the job.

Government should provide a technological laboratory to the technologists to use as their base of activities. This is necessary because the problems brought in by the industries need to be checked as to various categories of examination, including chemical, microbiological or engineering nature.

The technologist should always be aware of the way the industry concerned works, otherwise he will not be able to provide sensible answers to the problems brought to him by industry. One way to make sure that the technologist understands the industry is for him to pay frequent visits to the industry and learn the actual operation there starting from raw material to finished product.

At the very beginning of his visit, he might not be greeted with a smile, but once he demonstrates his wish to help they will probably let him see and learn, and eventually help.

As for the situation in this region, there seems to be less contact than there should be between industries and governmental staffs, including specifically technologists assigned to fish post-harvest technology.

Unless the technologist is experienced, he will not be able to communicate with the industry, or even to understand the questions asked. The needed capability cannot be achieved by the office-bound.

In some instance, an immediate response to a problem may not be possible. There may in such cases be an opportunity for the technologist to take up the question as his research subject, or at least, by laboratory examination, to prepare a satisfactory answer to the question.

Needless to say the research program of the laboratory must be relevant to the needs of the industries. Decisions should be made after a searching evaluation of the subject in terms of usefulness to the industries, the funds required, the point at which the project should be terminated, and so on.

From the perspective of the fisheries industry, research subjects can be chosen on the basis of the technologists study of current and future problems. In this context, knowledge and experience accumulated by the technololgist would play a significant role in building the reputation of the laboratory.

It is often thought that little technological improvement appears in the laboratory, in particular, those run by government. Although this may be true in some respects, each case needs to be separately evaluated. If one technologist indicates his enthusiasm for a certain subject and comes up with a proper solution to a problem, even a small one, he may earn trust from the industry.

In terms of close liaison between technologists and industries, demonstrations of the results of the laboratory's work will be most useful and will provide an opportunity to confirm with the industry that the outcome can be brought into commercial reality.

Extension work is an important part of the technologist's job, since people in the industry do not necessarily have access to the literature or to developments occurring elsewhere. Topics that may be dated for the technologist may be quite new to people who have been absorbed in

their own work. At the same time, people exclusively involved in certain products have less opportunity to acquire information about progress in other products.

Suspicion that confidential information may be leaked by technologists in governmental laboratories has been often noted. Government officials, including technologists, should always handle information collected about industries with great care and objectivity.

If people in government laboratories find it necessary to acquire confidential information they should work out an agreement with the industry in question beforehead, spelling out the conditions under which the material is handled.

Country Reports

Development of Fish Products in Indonesia

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Introduction

The largest country in Southeast Asia, Indonesia has over 13,000 islands and a population estimated at 180 million, 60% of whom live in Java island.

For these people fish is very important in nutrition making up 60% of the animal protein in the diet. Although the target of the fish consumption is 18 kg/year per person, current estimated consumption is 14 kg/year per person. This consumption is not evenly distributed. In some areas of Java for instance consumption is extremely low (ie 4 kg/year per person).

Fishery production in Indonesia has been increasing by about 4% a year and by 1985 the production was 686,423 tons in Java and 1,709,139 tons for the other islands.

Although 71% of fish landings are in Java, 60% of the population live on the island. This causes a problem in the distribution, transportation and product development.

Disposition and Distribution of Fish Landed

About 60% of the catch landed in Indonesia is distributed as fresh fish and 40% as preserved fish. The disposition and type of processing are shown in Table 1.

From Table 1 we can see that curing is the most popular processing method and in particular drysalted and boiled fish. Because of the short storage life of boiled fish *(pindang)* this method can be found in Java only, but drysalted fish which is produced in Sumatera and Kalimantan can be conveniently transported to Java. However in east Indonesia, curing is not so popular as in the west area where mostly fresh fish is consumed.

Curing Method

Curing is a simple method but it involves some challenging problems.

As in other Asian countries, dry salted fish is the most popular (Table 1). This is probably because the technology is very simple and cheap, uses simple storage methods and results in long storage life. The problems associated with curing trace back usually to low education and low capital, leading processors to process the fish without much attention to hygiene and efficiency.

Hygiene problems include lack of clean water and poor quality of available salt. Undeveloped techniques cause low efficiency in processing time, energy (even of solar energy) and some losses during processing. For example, in processing *ikan jambal* (dry salting

Table 1. Disposition by type of processing 1983 — 1985 (tons)

	Type of Processing							
Year	**Dry/Salting**	**Boiling**	**Smoking**	**Fermentation**	**Freezing**	**Canning**	**Meals**	**Others**
1983	611737	104647	88104	53062	60422	17478	14285	39610
1984	637513	121683	53403	45421	46183	16913	9317	19172
1985	708083	122195	53033	41845	58573	8054	6001	19285

of catfish) approximately 20% losses in weight and 30% losses in price are incurred because of insect (fly) infestation.

Pindang (boiled fish), a popular food in Java, is usually made from skipjack, bonito, mackerel, sardines etc. The problem associated with this method is short storage life. *"Pindang air garam"* which is processed by boiling the fish in the boiled brine for 15 minutes, has a storage life of two to three days. *"Pindang garam"* which is produced by boiling the fish with 30% salt for 3-5 hours in the covered pot, has 2-4 weeks storage life. However this method is difficult to develop outside Java because transportation facilities are not yet as good as in Java. This method has been modified in central Java by using high pressure cooking. The advantage of this modified method which is called *"Pindang Presto"* is that it breaks the bones making it useful for bony species such as milkfish. Although the processing method has been modified, storage life is still a problem because vacuum packaging is not yet applied. The use of high pressure cooking also consumes more energy and raises production cost. As a result this product is usually consumed by middle- and high-economic class city-dwellers.

Smoked fish are also common products in some area (i.e. Sumatera, east Java, South and North Sulawesi and Maluku). As with boiled fish, the storage life of this product is between 2-6 days. This makes it difficult to develop markets where refrigeration is not available. Some smoked fish from Sumatera have a long storage life (3-6 months). This is because the fish as raw material is very thin (glass cat fishes), and the smoked product is very dry (20% moisture content).

The other curing products are fermented products (fish paste, fish sauce and fermented fish) (Table 1). Usually, fermented products like fish paste and fish sauce are used for flavouring only and are consumed in small amounts.

All cured products are still quite important as protein sources, but in some cases need attention. In the development of curing technology, a new, simple small scale technique is probably needed. It should incorporate the following principles:

a. The equipment and technique used should be very simple in construction and in procedure, so that the fishermen/processor can use them without any trouble.
b. The cost of the equipment or production should be kept as low as possible.
c. The equipment and the processing technique should be efficient in the use of energy.
d. The design of the equipment should be such that it can be constructed with varied capacities.

The other problem related to cured products is the wide range of the standards of quality. These include safety problem, particularly with microorganism and heavy metal contamination, insecticide residues and probably formation of the toxic compounds for example, histamin, rancidity products, lipid — protein interaction product, Millard browning. These toxic compounds may need more attention by food scientist especially in Asia where so much cured fish is consumed.

Frozen and Canned Products

Freezing and canning technologies have fewer problems except in terms of the efficiency of the technique and equipment used. This varies with the management and capital cost of the factory.

Frozen products like shrimp, tuna are export products. However some frozen tuna (skipjack) are also for domestic consumption.

Canned tuna is an export product but canned mackerel and sardines are for domestic consumption. Currently, some canning factories also can molusca and crustacea for export.

Development of New Products

To maximise utilization of available fish, new products should be developed. The type of new products developed must be suitable in terms of fish landed, the level (simple or high) of technology used, geographical and socio-economic conditions. For example, while simple technology for curing may be used extensively in Java or in Sumatra, high technology would probably be more suitable in east Indonesia, particularly for utilisation of by-catch.

Particularly in east Indonesia, distribution and transportation of the raw material and end products are significant problems. Fresh

or frozen fish contain 80% moisture and 30-40% waste (head, gut, bone and skin) and therefore increase transportation cost. However mince fish or surimi can decrease 40-60% in weight, and fish protein concentrate or fish meal type-B (for human consumption) probably can save 80% of transportation cost.

Similarly we must decide whether to develop fish silage which contain more moisture, or fish meal which contain less moisture if continuity of supply of raw material is not ideal for investing in fish meal production. However, one must also consider the high transportation cost of fish silage.

In the development of mince fish or surimi, species of fish of specific chemical composition (in particular, type of protein and lipid content) will influence the quality of the product. A characteristic of tropical fisheries, with so many kinds of species is another problem to overcome in order to produce a constant quality and quantity of the product. In this case probably more analytical data especially proximate composition of tropical fishes is necessary.

Development of fish meal for human consumption (fish meal type-B) is probably useful. This product has been developed in some countries and it is possibly a better product but its high production cost is a problem.

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Present Status of Fish Processing Activities in Malaysia

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Introduction

Malaysians have been fish eaters traditionally and fish is one of the major source of animal protein for a large section of the population especially in the rural areas making up between 35% to 60% of the overall protein intake.

In 1985 the fishing industry provided jobs for 99,208 fishermen or about 2% of the nation's workforce and the figure is higher if those in marketing and processing are considered. The total quantity of fish landed was 462,861 mt of which 63% was consumed fresh, 24% was thrash and 13% was processed.

The processing industry has been expanding unchecked to meet demand by consumers. Lately, however, there has been a decline caused by a shortage in raw materials due to lower landings, due in turn to overfishing. There is overcapacity in some sectors caused by poor planning. Processors are slow to adopt new technology, are inefficient and not cost effective especially where competition is stiff. The industry also neglects cleanliness, sanitation, proper factory layout and is too dependent on local markets.

Status of Fish Processing

Apart from the fish canning factories and prawn/fish freezing factories, most fish processors are small-scale with capital less than M$100,000. Most are found in coastal area close to fish landing points. Their products consist of dried fish (anchovy, red snapper, squid), fish cracker (fish, squid, prawn, mussel), shrimp paste, fermented fish (fish sauce, shrimp sauce), fish *satay*, canned tuna/sardine, frozen prawn/fish/squid and fish meal for animal feed.

Dried Fish

The most common species turned into dried fish are Queenfish *(Chorinemus lysan)*, Red-snapper *(Lutianus malabaricus)*, Spanish Mackerel *(Scomberomerus guttatus)* and Jewfish *(Sciaena* spp.*)*. Production in 1985 was 7416 mt. Preparation of the fish is mostly done in the traditional way. Fish is dipped in 30% brine solution or salt is spread over the cut body. It takes one to five days before they are dried under the sun.

Because there are no standard preparation methods, similar products vary in colour, taste and chemical content.

Some processors use a higher percentage of salt and may even spray insecticide to prevent the growth of blowfly larvae. This industry has not changed much over time.

Dried Anchovy

Dried anchovy *(Stolephorus* spp.*)* is by far the most important single species with a production of 4583 mt in 1985. Fish fresh from the net are put in rattan baskets which are then dipped in boiling sea water or 10% brine solution for three to five minutes after which they are sundried for about six hours.

There is a standard for dried anchovy. The factors considered are size, species, degree of breakage, smell and colour.

Recently some processor in Tanjung Dawai and Pulau Langkawi have been using hot air driers to dry their anchovy. The dried anchovy is also kept in cold room. This development has been made possible by the high price of dried anchovy.

Dried Squid

Common squid (*Loligo* spp.), cuttlefish (*Sepia* spp.) and octopus (Octopodidae) are cleaned and washed with sea water and then dried under the sun on wooden racks. The processors are mostly wives of fishermen. The production in 1985 was 302 mt.

Fish Cracker

Fish cracker is a popular snack in the country and 5429 mt was produced in 1985.

Mostly, pelagic species are used, including the Wolfherring *(Chirocentrus dorab),* Herring *(Clupea/Sardinella* spp.*)* and trevally *(Selaroides* spp.*).*

Most fish cracker processors are found in the east coast states. The level of mechanisation varies. Although most have a mechanised mixer and mincer. Some still use the traditional hand-made method. The ratio of fish meat to sago flour or to tapioca flour is 1:1. Formation into cylindrical shape is still done by hand (although the Malaysian Agriculture Research and Development Institute (MARDI) has suggested use of a forming machine). The product is then either boiled or steamed for one to one and a half hours. The cracker can now be eaten fresh or dried.

There are many variations in quatity and colour reflecting the use of many species of fish, flour, recipes and processing methods. Fish cracker is widely available in plastic packs.

Fish *Satay*

This food is a recent product and is gaining in popularity. The main species used are goatfish *(Upeneus sulphureus).* Small jewfish and anchovy have been tried but the results have not been as good.

There are two levels of processing. The primary processors gut, clean and dry the fish. The fish is then sold to a secondary processor who rolls the fish and pours sauce on. The fish is then roasted in the oven for 25-40 minutes.

The quality of fish *satay* differ according to the species of goatfish and the sauce used. Only 121 mt were produced in 1985.

Shrimp Paste

Local shrimp paste is orange/red or chocolate in colour and most of it is made by small-scale processors in the traditional way. The raw materials is *Acetes* spp. to which salt is added at eight to ten percent by weight. The mixture is drained for five to eight hours to reduce the water content and then pounded. It is kept in wooden boxes for seven days. Before being sold the paste is shaped into oval or rectangular blocks, packed in paper and labelled. In 1985 the recorded production was 3146 mt.

Fish Sauce

Production of fish sauce in 1985 was about 90.45 mt, most of it produced and consumed by people in the east coast states of Peninsular Malaysia. The species used are anchovy, small goatfish or herring. The fish is gutted and cleaned before being put in brine solution in concrete tanks where it is kept for six to twelve months. The fermented solution is filtered and then boiled with brown sugar and lime juice. It is cooled before being bottled.

There has been little change in the method of preparation. A suggestion has been made by MARDI that the industry use starter culture/ enzymes to reduce the fermentation time.

Shrimp Sauce

This product is produced commercially in Malacca with a process in which cleaned Acetes are mixed with 20% salt and 6% cold rice. The mixture is kept in airtight earthern pots of 20-30 days.

Processors are now adding colour to their products to give them enhanced consumer appeal. Production in 1985 was 84 mt.

Fishball-Fishcake

Fishball factories are found mostly on the West Coast of Peninsula Malaysia. Most factories are partially mechanised with deboner and mixer. The bigger ones may have ball forming machines while the smaller factories shape the products by hand.

The recipe of the mixture is always a trade secret. Usually fish is mixed with salt, flour, chilli powder, onions, sodium borate and polyphosphate. The fishball is left to set in cold water for two to three hours. Production in 1985 was 1264 mt.

Tuna/Sardine Canning, Prawn/Fish Freezing

These are the products of big companies which usually practice quality control and which must meet the standards of the foreign countries to which they are mainly exported. In 1985, 5518 mt of fish and prawn was frozen and 14,184 mt of fish, prawn, molluscs and cuttlefish was canned. The factories are mostly mechanised except in cleaning and filling of raw materials.

Fish Meal

Most unwanted fish is converted to fish meal, and 21,367 mt was produced in 1985. The technology and the product quality are low.

Problems Faced by The Industry

Malaysia's fish landings have been declining in recent years and since fish is the most important raw material, this has severely affected some sectors of the industry. In 1981 the reported number of fish *satay* factories in Pulau Pangkor was 23 units. That figure has since decreased (Dr Mohd Ismail b. Abdullah *et al* 1987). The problems are made worse by the concentration of similar types of processors in the same areas — a situation that causes stiff competition for the raw materials and makes processors too dependent on a particular species — in this case the goatfish.

The Northeast Monsoon limits the numbers of boats and the types of fishing operations. Fish landings during these months are greatly reduced and the fish cracker industry in the East Coast States comes to a stop due to fish shortages to high prices for pelagic species.

The quality of fish landed varies with the handling method, with ice used, in some cases in insufficient quantity to prevent fish from rotting. The quality differences make it more difficult for processors to achieve high or consistent product grades.

Low level technology and the use of traditional processing methods contribute to high production costs and to much wastage. Since little attention is given to packaging and marketing of products processors depend only on local markets.

Role of Government, Statutory Boards and Other Institutions in Upgrading the Industry

In developing countries the government plays an important role in the development of the industry. In Malaysia a number of government agencies help in the growth and development of the industry.

Department of Fisheries (DOF)

DOF is responsible for managing the fish resource and is now encouraging the building up of the nation's deep-sea fishing fleet. The use of bigger and more sophisticated vessels will mean that the monsoon will not affect fish landing to the extent that it now does. DOF is also trying to introduce new and better fish handling methods to achieve more consistent quality of fish. DOF also does extension and training work in fish processing, though only on low technology processing methods and in cooperation with the industry.

Fisheries Development Authority (LKIM)

This agency is helping processors, especially fish cracker manufacturers, to produce a standard cracker for export.

In the area of fisheries development LKIM sets up model factories run by fishermen as business entities.

MARDI

All fisheries research and development work is done by MARDI. They also do extension work through an 'adoption' scheme in which selected processors are given regular training advice and monitoring by MARDI's staff.

Ministry of Health

All regulations and enforcement of food matters, including sanitation and cleanliness of factories are under the jurisdiction of the Ministry of Health.

Agriculture Bank

This bank offers loans at a lower interest rate than the prevailing commercial one.

With all these inputs, it is expected that the fish processing industry will be improved in the future.

Regular training by MFRD is also helping our industry because it offers a chance for our processors to see a good processing centre and new products which they make. Unfortunately the training is limited. I hope more training can be provided in the future.

DOF is setting up four regional extension centres which will be equipped with fish processing facilities. We hope to train more processors and impart new technology in a good, clean and properly planned workplace.

The industry has potential. We intend to develop it.

Department of Fisheries of Malaysia. 1986. Annual Fisheries Statistic 1985.

Dr Mohd Ismail Abdullah b. Omran Noorman. 1978. Status industri memproses ikan masa kini — Seminar Galakan Pemproses Ikan, 21-23 September 1987. Kuala Trengganu (in Malay).

The Fish Processing Industry in the Philippines: Status, Problems and Prospects

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Background

The Philippines is fortunate to be endowed with rich fisheries and aquatic resources where its population can always turn to for food. Fish is very important as a cheap source of animal protein in the diet. Our consumption of food fish is comparatively high by world standards. Our average per capita consumption of 41 kg annually is one of the highest in Southeast Asia. Table 1 shows our mean per capita fish consumption by geographical area.

The fish processing industry not only provides the valuable animal protein requirement but also generates employment opportunities to over a million Filipinos. It is also an important foreign currency earner and holds considerable potential for development.

Fish production showed an increasing trend from 1.3 million mt in 1975 to over 2.0 million mt in 1986 (Table 2). The increasing fish production is the basis of the fish processing industry. Inspite of the many obstacles and problems, the industry has expanded significantly over the past years. Export likewise steadily increased from 25,988 mt (₱328M) in 1975 to 101,448 mt (₱4,863M) in 1986 (Table 3). On the other hand, importation declined from 23,038 mt (₱111M) in 1983 to 6,097 mt (₱50.2M) in 1984 as shown in Table 4. The country's major imports in 1981 were canned sardines and mackerel mostly from Japan and Thailand and fishmeal from Peru.

Given the much-needed incentives to carry out the desired improvement, the industry possesses the necessary success factors towards national recovery.

Table 1. Mean per capita fish consumption in the Philippines by geographical area

Geographical Area	Fish Consumption kg/yr
All Urban	41
Metro Manila	34
Other Urban	45
Rural	41
Luzon	37
Visayas	38
Mindanao	45

Source: Fisheries Statistics of the Philippines, BFAR 1984.

Table 2. Total fish production by quantity & value 1975-1986

Year	Quantity (mt)	Value (₱)
1975	1,336,803	5,919,127
1976	1,393,483	7,297,946
1977	1,508,855	8,809,203
1978	1,580,404	9,477,276
1979	1,581,303	10,536,747
1980	1,672,254	11,644,350
1981	1,772,897	13,953,798
1982	1,896,983	15,063,966
1983	2,110,230	18,981,459
1984	2,080,439	25,649,933
1985	2,052,111	31,297,268
1986	2,089,484	37,331,483

Source: Fisheries Statistics of the Philippines BFAR.

Table 3. Total export of fish & fishery products by quantity & value 1975-1986

Year	Quantity (mt)	Value (₱)
1975	25,988	327,995,971
1976	23,974	330,272,807
1977	37,534	395,365,033
1978	48,438	532,213,555
1979	64,890	781,736,033
1980	76,179	939,294,463
1981	83,736	1,251,142,136
1982	68,265	1,119,685,276
1983	75,589	1,592,884,033
1984	63,055	2,179,380,361
1985	95,077	3,496,095,733
1986	101,448	4,862,738,898

Source: Fisheries Statistics of the Philippines BFAR.

Table 4. Total importation of fish & fishery products by quantity & value, 1975-1986.

Year	Quantity (mt)	Value (₱)
1975	86,910	294,730,712
1976	64,111	266,021,297
1977	38,557	205,082,803
1978	47,955	229,528,950
1979	45,874	207,038,680
1980	53,401	274,077,361
1981	46,850	288,434,119
1982	83,445	443,677,138
1983	23,038	110,908,875
1984	6,097	50,269,335
1985	28,755	118,180,573
1986	69,085	385,657,601

Source: National Census & Statistics Office, 1986

Existing Fish Post-Harvest Technologies

1. Fresh Fish Handling Practices in the Philippines

It is estimated that up to 30% of fish landed at Navotas are physically damaged prior to auctioning and most damages occurred even before the fish is landed (Kamari and Sayers, 1979). Such huge damage can be attributed to the various improper practices employed during the subsequent activities after landing the catch.

Due to lack of proper facilities for icing, transportation and cold storage, a considerable amount of fish spoils during distribution.

Handling on Board

In most fishing areas, the degree of care exercised in the handling of fish on board the vessel and off-shore depends directly on the value of species. High value species are better taken care of than low value ones, thus the intrinsic quality of these species is usually quite good. Low-value species are poorly iced and little protection from contamination is provided; hence, the quality on landing ranges from poor to rejects.

Some fishing vessels are not properly cleaned and sanitized in addition to the widespread use of tubs, baskets, wooden boxes as fish containers causing contamination during storage of fish resulting in poor quality, spoilage, off-odours and reduced shelf-life.

Handling at Landing Site & Auction Halls

When fish are unloaded at the landing ports, the ice are often discarded. The fish are transferred to other containers for auction. More often, they are unloaded on floors under direct sunlight with little or no ice, thereby exposing them to further contamination.

Water from the harbour is sometimes used to wash the fish. Harbour water is usually contaminated, thus aggrevating the spoilage of fish.

Packaging and Transportation

The dominant type of containers used for fish handling and distribution is a conical steel tub known locally as *"banera"*, having a capacity of approximately 30 to 40 kg of fish. A bigger *banera,* approximately 70 kg capacity is used for transporting fish to some landing areas and retail markets. Other types of containers are also used, such as those made from rattan, bamboo, timber, styrofoam, and plastic containers. These vary from one region to another although the *banera* still remains the most common.

The fish is iced in *banera* on board the vessels and transferred to auction halls in the same containers. The *baneras* are usually

owned by resident brokers, some of whom also own fishing boats. Some boat owners market their fish through regular brokers who charge a 7-10% commission on sales. Some brokers lease/rent *baneras* to their established wholesale and retail clients and charge a minimum deposit. Some buyers provide their own fish containers.

Fish for transportation to distant markets is repacked and iced in the *banera* and loaded into insulated trucks. Timber planks are placed between successive layers of *baneras* to facilitate stacking but because the *baneras* are always overfilled, damage to fish at the bottom layers due to crushing becomes inevitable.

Large rigid trunks, both insulated and open ones are commonly used for medium to long distance transportation. When open trucks are used, the fish are packed in styrofoam boxes with ice. The use of this type of container is now becoming popular. To make them more durable, wooden frames are provided for support and protection against rough handling.

Fish for local distribution is normally transported either by privately-owned *jeepneys* or small pick-up trucks with a capacity of one ton or less.

The introduction of high density polyethylene plastic (HDPE) containers has improved the fish handling practices in the fishing industry. Trials have been successful in Iloilo and Bacolod and they have been found to be ideal for handling and distribution of milkfish from the production areas to the auction centers. These containers offer the following advantages: 1) ease of handling 2) better presentation of produce at auction, and 3) better utilization of space in vessels (Sayers, 1983).

2. Fish Processing Technologies

Table 5 shows the approximate number and type of fish processing plants in the Philippines by region. It is interesting to note that the fish processing industry has expanded as shown by the increasing variety of fishery products, utilization of non-traditional resources and production of new fish products. This indicates that the industry has promise for potential development.

Traditional Fish Processing Methods

The fish processing industry in the Philippines generally ranges from small to medium cottage industry level employing the traditional methods of salting, drying and smoking with the small units operating in strategic locations all over the country. The industry absorbs surplus fish catch during the peak season, offers a ready market at almost the same price as fresh fish during the lean months and provides storable protein diet items. The species of fish most commonly used and their product forms are shown in Table 6.

Drying

Drying is one of the oldest and simplest methods of preserving fish in the Philippines and in many tropical countries. This industry plays an important role in stabilizing the utilization, distribution, and marketing of fish resources. The product is acceptable to all income groups and has high export potential.

Sun-drying as a method of preservation remains popular in the country because of its low-capital investment and other advantages. The techniques are usually simple and do not require high technology or expensive equipment. At present, approximately 38% of the total catch is processed into dried fish products. There are 658 dryig plants in the country today, 415 of which are registered. The Philippines showed the highest per capita consumption of dried fish in Southeast Asia or 4.4 kg annually (FAO, 1980).

Fish drying activities in the country vary according to the availability and suitability of raw materials for drying. As the processors are generally small scale family establishments, most of them have limited capital and do not receive assistance provided by various government agencies and financing institutions. These factors coupled with existing conditions in areas difficult to reach limit the development and improvement of the industry. Nevertheless, in some areas in Palawan and Cagayan, some processors have realized the relative benefits of using artificial dryers for fish. In Cagayan, oven-type agro-waste dryers are used for drying tiny shrimps which are consumed locally or even exported to Japan. The use of these artificial dryers was introduced in the mid-seventies.

Salting (Fermenting)

The manufacture of fish sauce *(patis)* and fish paste *(bagoong)* is a major industry in eight regions of the country namely: Region 1,2 3, 4, 5, 8, 11 and 12. (Macalincag-Lagua and Payofelin, 1978). Production peaks during the month of April and decreases in October. By-

catch market surpluses, like tiny shrimps, *Acetes* sp. and other species of low-commercial value are also absorbed by the industry, thus preventing wastage of resources.

The technology employed by the processors is simple, which consists basically of mixing the salt and fish or shellfish and allowing it to ferment for a certain period of time, depending on whether fish sauce or fish paste or both are desired as products. The containers used to stack the mixture vary from earthenware jars to plastic containers and concrete tubs.

To hasten the fermentation process, some processors have adopted techniques such as exposing the containers of salt-fish mixture to sunlight with the containers covered, and burying the containers partly into the ground, on the principle that fermentation is faster at higher temperatures. Artificially produced enzymes, such as pepsin in powdered form is now manufactured and some fish processors are already using it. The use of enzymes from papaya was introduced by Guevara *et. al.* in 1973.

Poor product quality and the presence of extraneous materials are among the reasons for rejecting fish paste and fish sauce exported in 1980 (Orejana, 1983). This is primarily due to the fact that proper hygiene and sanitation is hardly practised by some of our processors.

Table 5. Approximate number & type of fish processing plants in the Philippines by regions, 1986

Regions	No. & Type of Fish Processing Plants							
	Drying	Smoking	Fish Paste Manufacture	Fish Sauce Manufacture	Canning	Fishmeal Manufacture	Others	Total
1. Dagupan	5	24	72	72	—	—	—	173
2. Gagayan	19	24	21	21	—	—	2-shrimp noodles	87
3. Pampanga	7	96	23	—	—	—	4-salted fish	130
4. Southern Tagalog	132	115	39	85	1	—	7-shellcraft	379
5. National Capital Region (Metro Manila)	20	11	48	48	21	4	—	152
6. Naga	254	128	66	1	2	1	4-shrimp cake 2-jellyfish	458
7. Iloilo	136	12	9	8	4	—	1-shrimp *kroepeck*	170
8. Cebu	/	/	/	/	2	—		2
9. Tacloban	17	—	13	—	—	—		30
10. Zamboanga	39	1	9	10	5	—		64
11. Cagayan de Oro	/	/	/	/	1	—	1-shrimp *kroepeck*	2
12. Davao	3	15	35	7	—	—	5-shrimp *kroepeck*	60
13. Cotabato	26	14	29	-	—	—		69
TOTAL	658	440	364	247	36	5	26	1776

Note: — none
/ presence of fish processing plants; number not given

Table 6. Most common species & their product forms

Species	Product Forms								
	Fresh/ Chilled/ Iced	Dried	Salted-Dried	Smoked	Fermented	Pick-led	Canned	Fish meal	Others
1. *Stolephorus commersonni* (anchovies)	x	x	x	x	x				x boiled-dried
2. *Caranx crumenophthalmus* (Big-eyed scad)	x		x	x					
3. *Caranx* sp. (Cavalla)	x		x						
4. *Leiognathus fasciatus* (Common slipmouth)	x	x	x		x			x	x boiled-dried
5. *Sciaena dussumieri* (Croaker)	x		x		x				
6. *Sardinella perforata* (Deep-bodied herring)	x		x	x	x				
7. *Sardinella fimbriata* (Fimbriated herring)	x		x	x	x				
8. *Cypselurus oligolepis* (Flying fish)	x		x		x			x	
9. *Anodontostoma chacunda* (Gizzard shad)	x		x						
10. *Epinephelus* sp. (Grouper)	x		x						
11. *Oxyunchthys microlepsis* (Goby)	x		x						
12. *Megalepsis cordyla* (Hairtail)	x		x						
13. *Scombeeides lysan* (Leather jacket)	x		x	x					
14. *Ophicephalus striatus* (Mudfish)	x								
15. *Mugil* sp. (Mullet)	x		x	x	x				
16. *Decapterus macrosoma* (Roundscad)	x		x	x	x		x	x	
17. *Sardinella longiceps* (Sardines)	x	x	x	x	x		x	x	x boiled-dried

Table 6. (continued)

Species	Product Forms								
	Fresh/ Chilled/ Iced	Dried	Salted-Dried	Smoked	Fermented	Pick-led	Canned	Fish meal	Others
18. *Teuthis javus* (Siganid)	x	x	x						
19. *Scoliodon* sp. (Shark)	x								x shark liver-
20. *Lutjanus* sp. (Snapper)	x		x						
21. *Nemipterus japonicus* (Nemipterid)	x		x		x				
22. *Datnia pumbea* (Silver perch)	x	x	x		x				
23. *Rastrelliger brachysomus* (Short-bodied mackerel)	x		x	x					
24. *Euthynnus* sp. (Tuna)	x		x	x			x	x	x boiled
25. *Scomberomorus* sp. (Spanish mackerel)	x			x					
26. *Callinectes* sp. (Crabs)	x								
27. *Sepia* sp. (Cuttlefish)	x								
28. *Ripilema* sp. (jellyfish)			x		x				
29. *Perna veridis* (Mussels)	x	x		x		x			
30. *Penaeus monodon* (Prawns)	x								
31. *Holothoria* sp. (Sea cucumber)	x			x		x			
32. *Gracilaria* sp. (Seaweeds)	x	x							
33. *Penaeus* sp. (Shrimps)	x	x							x *polvoron* x *kroepeck*
34. *Loligo* sp. (Squid)	x	x	x						
35. *Acetes* sp. (Tiny shrimp)	x	x			x				x *kroepeck*

Smoking

Fish smoking is believed to be introduced into the Philippines by the Chinese. This method preserves the fish, enhances its flavour and improves its appearance. The method is simple and may not require expensive machinery. The raw materials are locally available and the products are widely acepted. The total production of smoked fish in 1982 was 455.6 mt valued at ₱6,367,802 (BFAR, 1982) of which 46% was marketed locally and 54% was exported (Mendoza, 1986). Exports were mainly smoked tuna and milkfish.

Fish smoking is not practiced throughout the country and many coastal areas prefer to dry or ferment excess fish than to smoke them (Mendoza, 1986). Six of 12 regions of the country process smoked fish (Macalincag and Payofelin, 1982); they are Central Luzon (Region 3), Taglog Province (4), Bicol Region (5), Central Visayas (6), Negros Oriental (7) and Southern Mindanao (9). Milkfish is smoked either whole, split, boneless and soft-boned and is sold locally while smoked-dried tuna *(katsuobushi)* is mainly for export to Japan.

Some fish sold in Metro Manila come mostly from Salinas, Navotas and Mercedes, the former source being preferred in Metro Manila (Mendoza, 1986).

Due to non-uniformity in the processing method, smoked fish show varying degrees of product quality, shelf-life and acceptability.

3. New Fish Processing Methods

Fish Canning

Canning has grown to a certain degree. A number of canning factories are now operating in Metro Manila and in some provinces. At present there are 30 fish canning plants in the country 21 of which are operating in Metro Manila while the rest are located in other provinces. However, operation still vary from excellent to poor; that is from high degree of technological sophistication to primitive manual operations. The most commonly used species are those utilized by the fish curing industry such as milkfish, sardines and mackerel which poses a problem on the raw material supply during some time of the year. Other raw materials like shrimps, squid and crabmeat still need to be tapped. Assessments made by BFAR technologists showed that the most common defects in local canned sardines are:

a) Mislabelling — contents are not the same as those stated on the label.

b) Fish are not processed immediately after thawing, resulting in off odours and mushy texture of products.

c) Proportion of solids to sauce is not within the required proportion of 60/40.

d) Cans are defective. Fracture on can seams occurs due to too tight preasure on the rollers. Cans are sometimes dented.

Considerable attention should be given to this industry to improve product quality to enable it to be more competitive in the export market and at the same time satisfying the demands of the local consumers.

Freezing

Freezing is a big help to the fish processing industry in two ways. It provides efficient preservation and storage of the catch for future processing and caters to the needs of the export of frozen fish such as tuna, shrimp, and other products.

A majority of Filipinos have strong preference for fresh fish to frozen ones because of the undesirable freezing procedures in some establishments which result in sub-standard frozen products. Contact plate freezers are widely used while air blast freezers are employed only by a few exporters.

Manufacture of Minced Fish Products

Fish balls are the most popular among the minced fish products. It is prepared from white meat species which is seasoned with sugar, salt, monosodium glutamate and starches as thickening agents. However, most plants engaged in the industry lack education on proper sanitation and flies appear to be a major problem in the processing area. Products are sold locally. This industry may absorb trash fishes and market surpluses including fresh water species.

Studies are now being done by BFAR to maximise the utilization of by-catch such as croakers, lizardfish and sharks into comminuted forms, and extruded as breaded products. Fish balls are popular products and are now sold almost everywhere. Fish *quekiam* and fish burger are now being promoted in the

market. By-catch are also good raw materials for the manufacture of other fishery products like fish salami, fish noodles, *kroepeck*, fish sticks and others. With appropriate processing technology, by-catch can become an important potential source of protein for human consumption.

Shellfish Processing

Processing of shellfish is confined mainly to the more popular crustaceans and molluscs. Shrimps and prawns, because of their high market value are mostly exported in fresh, frozen or chilled forms; similarly with lobster tail and crabmeat. Dried shrimp, crabmeat and tiny shrimps *(Acetes* sp.*)* are also exported to Japan, U.S.A. and other countries. Molluscs like abalone, mudsnail, mussels, oysters, cuttlefish, squid, octopus and arkshell are also exported in their live or processed forms such as dried, salted and frozen/chilled. Processing technologies fot shellfishes have been developed but most of them are exported either because of high export demand and abundance in catch or because they have no local demand at all. However, considering the present availability of appropriate technologies, utilization or other potential species shows promising prospect.

Bangus Deboning

The changing tastes of consumers and their demands for improved acceptability of bangus, a bony fish, gave rise to the milkfish deboning industry. This industry caters for the institutional markets such hotels and restaurants which have gained popularity in their broiled fish products *(inihaw)*. It also caters to the demand of Filipino communities abroad who have marked preference for convenience items. Today, this industry generates employment and adds to the foreign currency earnings through exports. The product is exported in frozen, marinated, dried and smoked forms.

Manufacture of Boiled Tuna
(Sinaing na Tulingan)

The industry is a lucarative business in the Tagalog Region. It utilizes frigate tuna, bullet tuna and eastern little tuna. The process or boiling the fish with salt enables the fishermen/producers to sell the product to other areas where the demand is high without the risk of spoiling the fish as it keeps for 4-7 days at room temperature. The technology is now being promoted especially in areas where the catch is abundant. However, the product is consumed locally only.

Processing of Boiled-Dried Fish

This is a new product; the technology was introduced by the Japanese. Small species like slipmouth *(Leiognathus* sp.*) locally known as "sapsap"*, and anchovies *Stolephorus commersonii* are manufactured into boiled-dried products. The fish are boiled in a concentrated brine solution and dried under the sun. This methods preserves the product and enables the processors to market them in areas where they are in demand.

4. Other Fishery Products and By-Products

These are generally produced by small-scale factories, and the product are either consumed within the locality where the product is produced, and for the export market, both for direct human consumption and for industrial purposes.

Utilization of By-Catch

Trash fish landed as by-catch comprises as much as 50% of the total marine commercial catch in most ASEAN countries (CIDA, 1985). Most of them are now sold at relatively low prices for reduction to fishmeal, fish sauce/paste processing or for consumption by low-income groups.

Fishmeal Processing

Fishmeal production also depends to some extent on by-catch in addition to the fish scraps and wastes in processing, particularly from the fish canning industry where such wastes constitute approximately 40% of the raw materials. In the frozen food industry, the waste materials constitute 80% of live crabs and 30% of shrimps (PCARRD, 1982). Rejects in dried and smoked fish and fish offals from filleting are also absorbed by the fishmeal industry. However, there is a need to improve the processing techniques in fishmeal production as its quality is believed to be inferior to imported meals. Nevertheless, our importation of fishmeal was drastically reduced from 24,621 mt (₱25,232,047) in 1980 to 4,816 mt (₱30,712,389) in 1984 (Fisheries Statistics, 1984).

Shark Liver Oil Extraction

Shark fishing for squalene oil started in Cagayan in 1980. The extraction of oil from

shark liver was practiced during this year when there was high demand of shark oil in Japan and France. The process is crude because of the inavailability of appropriate processing equipment. The total oil production from January to May 1986 was 5.4 mt. The price is ₱7,000.00 per drum weighing 180 kg. The productive areas for shark fishing are Babuyan Channel and Pacific Ocean. There are two operators engaged in the business which are both located at Aparri, Cagayan.

Problems Facing The Fish Processing Industry

The fish processing industry is bugged by many problems which are either industrial, socio-economic, institutional or political in nature. Nevertheless, inspite of them the industry continues to grow and it has gone a few steps ahead towards its full development. The various problems of the fish processing industry are summarized below:

1. Huge losses in value of fish and fishery products due to poor handling practices, sanitation and hygiene which results in inadequate supply of raw materials for processing and inferior quality of fishery products. This is also attributed to lack of adequate facilities necessary for handling, processing and distribution.
2. Poor hygiene and sanitation and non-standardized procedures encourage insect infestation of cured products and non-uniformity of product quality.
3. Slow transfer of new technologies and strong resistance to new techniques due to lack of proper education and training on proper fish handling, processing and quality-consciousness among the fish processors. The lack of facilities and equipment needed for extension and technology dissemination also hinders technology transfer. Thus, the processors still cling to the traditional methods which are in most cases crude and sub-standard resulting in either poor quality or product rejects.
4. Lack of capital limits the processors' ability to expand their business and explore the utilization and processing of other fishery resources. Thus, most operations are confined mainly to traditional processing methods good for small to medium-scale operations.
5. Lack of proper coordination among agencies and other institutions involved in the fishery industry resulting in gaps and duplication of some functions while neglecting other important areas.
6. Lack of government funds to carry out effectively and efficiently the much needed extension service and other forms of technical assistance that the industry needs.

Government Programs and Projects

The government through the Bureau of Fisheries and Aquatic Resources (BFAR) implements the Fish & Fishery Products Utilisation Project under the Expanded Fish Production Program. This program is implemented hand-in-hand with other programs and projects of other research and development institutions. The programs aim primarily at promoting import substitution and expanding fishery exports. To realize these objectives, the following activities are being undertaken.

Research

To maximize the utilization of fish and fishery products, research studies directly concerned with converting the once non-utilized fish species and other minor sea products are being conducted. Studies on the improvement of handling and processing techniques of traditional products to suit consumers' demands are likewise being done.

Extension Service

Results or research studies in fish handling, processing and utilization are disseminated through lectures, demonstrations, seminar/workshops and technical information services in order to encourage the processors to adopt new technologies and the private investors to engage in fish processing industry. Such medium of technology transfer helps promote import substitution and develop export products and at the same time upgrade the quality of fish and fishery products.

Product Development

Corollary to research activities, studies on producing other products that could be derived and developed from various fish and fishery products are being undertaken. Likewise, traditional processing methods are improved by applying appropriate technololgy and using suitable processing equipment. Available tech-

nologies and new ones are verified and pilot scale production of fishery products are being undertaken.

Training

Training courses and seminars/workshops are conducted for interested parties by the staff of the Fisheries Extension Division and the Fisheries Utilization Division of BFAR. The former conducts training courses on improved fisheries extension methodologies for trainers and extension officers while the latter conducts training on fish handling and processing for operators. A one-week training course on fish handling and processing is an on-going project of the BFAR through the Fisheries Utilization Division where proper fish handling and processing methods are taught to housewives, processors, businessmen, students and industrialists. This serves as a medium of technology transfer to disseminate the technology to the industry. Training courses on fish handling and processing are given to upgrade the skills of the technologists and extension officers and make them more effective in their jobs. Other academic and research institutions implement similar trainings.

Recommendations For Further Development of The Industry

1. Implement an intensive educational information and technology dissemination program nationwide designed to:
   a. effect technology transfer on product development and improvement.
   b. demonstrate proper handling, hygiene, sanitation and standard processing procedures.
   c. encourage quality-consciousness in fish processing. This may include print media, TV and radio programs, training courses and workshops.
2. Provision of trained fish inspection staff to advise and provide quality control guidance in the regions.
3. Appropriation of sufficient funds for research and development projects to support the fish processing industry.
4. Expansion of fish inspection and quality control laboratories in the regions as a show-window to the industry where appropriate fish processing technologies may be demonstrated.

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Fish Processing in Singapore

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Introduction

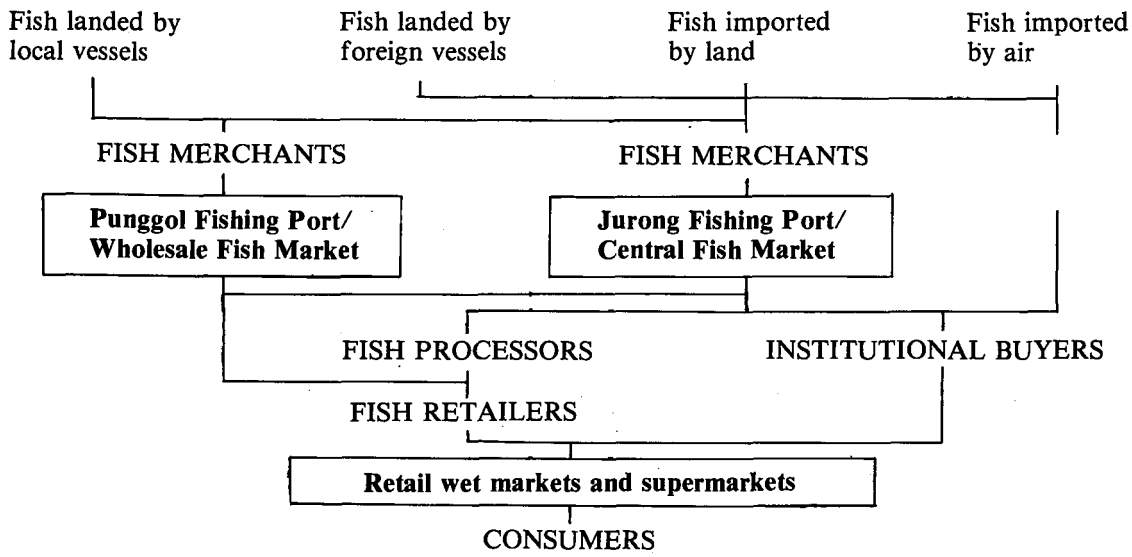
Singapore consists of the island of Singapore and some 57 islets within its territorial waters. It is located about 136.8 km north of the Equator. The main island is about 41.8 km in length and 22.9 km in breadth and has an area of 570.4 sq km. Its coastline is about 132 km. The total land area is 621 sq km including that of the islets. The population of Singapore is about 2.56 million. Being the largest port in the world in terms of total volume of cargo handling, it is located at the cross roads between the Indian and Pacific Oceans. At the southern tip of Peninsular Malaysia, Singapore is located at the centre of major fish producing countries like Malaysia and Thailand at her north, and Indonesia at her south.

Geographically, Singapore has limited territorial waters which impose constraints on its fishing activities. However, Singapore has developed into a cosmopolitan city state from a fishing village after one and a half century. With a population close to 3 million people, Singapore today has become one of the countries in Asia with a high per capita consumption of fish of about 32 kg. The local production of about 20,000 tonnes per year hardly meets the demand of the population. Therefore, most of the fish and other fish products are imported; for chilled and fresh fish alone, the import volume is close to some 90,000 tonnes a year.

Fish Supply Situation

The local catch is landed by trawlers operating in their traditional fishing grounds in the South China Sea. This is supplemented by imports of chilled fish mainly from West Malaysia, Thailand and Indonesia. Those from Malaysia are trucked to Singapore by road. Those from Thailand are imported either in refrigerated container trucks from southern Thai provinces, air-flown to Singapore or landed by Thai fishing vessels. From Indonesia, the fish are air flown to Singapore as well as by fish carrying boats from nearby Indonesian islands. The pattern of imports and distribution of chilled fish is shown in Figure 1.

Fig. 1. Distribution of chilled fish in Singapore



Other than chilled, fish are also imported in frozen form. Some 48,000 tonnes of frozen marine fish, prawn and molluscs, and 29,000 tonnes of tuna were imported in 1986.

Most of the fish are consumed in fresh or chilled form in Singapore. The general preference of fresh and chilled fish as diet of the population has supported the existence and development of the local fishery industry. Sufficient marketing facilities such as fishing ports and wholesale fish markets are provided and managed by the Government to ensure fast distribution of fish to the consumers. The same facilities have also contributed to the growth of the fish processing industry in Singapore. With rapid urbanisation and industrialisation for the last decade, consumption of processed and semi-processed fish has been also gaining popularity in Singapore.

Fish Processing

The fish processing industry in Singapore can be grouped under two categories in terms of the scale of operation, viz factories which are export orientated and manufacture high value added products for overseas markets, and factories which are small and medium in operation-size and make traditional fish products for local demand and regional markets.

Four major groups of fish products can be indentified in the local fish processing industry. They are: frozen fish products like fillet, fish jelly products like fishballs and fish cakes, snack food like dried squid and *kerupok*, and seafood delicacies like sharkfin and fish maw.

Frozen Fish Products

Singapore exported about 30,000 tonnes of frozen fish, fillet and prawn in 1986. Raw materials are generally imported and further processing, involving number of factories, produce fillets and individually quick frozen products.

The large factories have processing areas of 1000 sq m and above, and also good cold storage facilities. They produce mainly frozen fish, fillets, cuttlefish, and prawn for export markets. Proper packaging and quality are important for the products so that they have a competitive edge over other products from other countries in the world markets. These factories normally have proper processing lines equipped with good processing machineries. They also employ qualified workers to monitor and assure the quality of the products.

Some medium-sized factories also produce frozen fish products for local markets and their products are supplied to restaurants, institutional buyers, supermarkets and merchant shipping vessels. For such factories, processing is carried out as and when there is an order or sufficient supply of raw materials. Normally, the factories are equipped with mimimum processing machineries since automation may not be justified for such low volumes of turnover.

Fish Jelly Products

The consumption of traditional fish jelly products in Singapore has been increasing in the last few years. Fishballs and fish cakes are popular as they are served together with carbohydrate-based foods such as noodles and rice as fast food to the consumers. There are 30 factories manufacturing fish jelly products with an estimated daily production of 28 tonnes. The main products are fishballs, fish cakes with a variety of ingredients, egg rolls, *ngoh hiang* (rolls stuffed with minced fish meat and other meats and vegetables), cuttlefish balls and *young tofu* (soy-based products stuffed with minced fish meat).

Raw materials such as Dorab *(Chirocentrus dorab)* and Coral Fish *(Caesio* spp.*)* which are traditionally used and known to be good for making fishballs and fish cakes are imported from neighbouring countries through the normal marketing channels as for chilled fish. As these fish are getting more expensive, surimi blocks are imported mainly from Thailand as alternative raw materials. In 1985, some 1,400 tonnes of surimi blocks were imported. There is also a trend for the import of chilled leached meat, fillets and headed and gutted fish for use as raw materials. The industry also use frozen Blue Whiting and Grenadier (fish from cold waters) although their supplies are not regular.

The fish jelly product manufacturing industry started as a backyard industry when the processors were located in the city. As a result of urbanisation, old buildings were demolished and some of these family-run businesses have shifted to light industrial areas. During the resettlement, many processors have chosen to terminate their business. However, most of those who have been resettled are still operating the business on a small scale. Tech-

nically, the industry needs advice on process line quality control, post-processing handling of products and packaging to improve product shelf-life and marketing.

Some mechanisation in fishball and fish cake making have been introduced in the last decade. Processing equipment such as meat-bone seperator, grinder, product shaping machines and fryers are now used to replace the labour intensive work in extracting fish meat from the raw materials and subsequent processes in cooking. The final products are either fried or boiled although they are not completely cooked. They are then kept cooled to room temperature and chilled for distribution.

Snack Food

Snack food production also started from family-run backyard industry like the fish jelly products. The snack food produced from seafood includes seasoned and dried squid, seasoned and baked fish (*satay* fish), fish and prawn crackers. Most of the processing works carried out in the factory are simple. It is due to the fact that the raw materials are already semi-processed. The unfried fish and prawn crackers are imported from neighbouring countries. They are simply fried and later packed in the factory for sale and distribution. Since the semi-processed raw materials are imported, there is no way for the manufacturers to check on their quality which may affect the quality of the finished products.

Similarly, seasoned and dried squid are processed from dried raw materials imported. The raw materials are softened by soaking in water, and then flattened by passing through a series of rollers. Seasoning materials likes chilli, sugar, soy sauce and spices are later added followed by drying, baking or broiling.

As the markets for these products are mainly domestic, the processors do not have the incentives to upgrade the methods of processing which may also increase the cost of production. Apparently, the processors are contented with the present status of the industry where some sort of mechanisation is introduced in the packaging of the finished products. Product diversification and development should be looked into to improve the image of the snack food industry using seafood as raw materials.

Seafood Delicacies

Some dried seafood have long been recognised as health food in the Orient. These include shark fin, sea cucumber, fish maw, abalone and scallop. Such products fetch a high price in the market. For instance, Singapore exported about S$23 million of dried sharkfin in 1986. The processing of these products is fairly simple and labour intensive. Most of the raw materials required are imported and have already been semi-processed.

The dehydrated raw materials are soaked in water again for cleaning or repeated boiling. High-priced products like sharkfin are usually cleaned manually to get rid of the skin, meat and other foreign materials on the finrays. They are then dried again and packed into consumer packs for sale or export.

Problems Faced in the Processing Industry

As a net fish importing country, Singapore's processing industry is faced with the problem of supplies of raw materials. Unlike fish processing factories in a fish producing country, the factories have to secure sufficient raw materials to keep the production lines running. Sufficient cold storage facilities must be available to stock up the raw materials in order to offset the fluctuations in supplies.

The manufacturers depending on the import of fish for processing have difficulties in monitoring the quality of raw materials. The role of sourcing and purchasing raw materials has become one of the important activities of the processor. To ensure good quality of the raw materials, some of these are imported by air to Singapore and large quantities are often purchased when the price is right.

The production of high value processed products is to ensure future growth of the industry. Some processing technologies have to be upgraded through the use of modern machineries. Quality has to be emphasised in the finished products to gain competitiveness in the export markets. For domestic market, further improvement in product packaging is needed to extend the shelf-life of finished products and to promote marketing. Concerted effort of the processors is needed to maintain or increase their market shares whether local or

overseas. Otherwise, they will be losing their competitiveness as a result of rising production costs.

Government Bodies Regulating The Industry

The fish processing industry is regulated by the Fisheries Division of Primary Production Department and the Food Section of Ministry of Environment. Thirteen fish processing factories are licensed under the Fish Processing Establishment Rules, 1971 by the Primary Production Department. Regular inspections are conducted to ensure good sanitary practices on the processing premises. The Department also issues health certificates for exports of fish products manufactured by these factories. For the fish jelly product industry, the Department's Fisheries Postharvest Technology Section often conducts training courses for processors or plant managers to upgrade their knowledge in production and the use of machineries in processing.

Fish processing factories marketing their finished products locally are regulated by the Ministry of Environment under the Environmental Public Health (Food Establishments) Regulations, 1973. This Ministry also regulates the use of additives in food processing under the Sale of Food and Drug Act.

Improvement in Fisheries Post-Harvest Technology in Thailand

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Present Status of the Fish Industry

The fisheries of Thailand developed at a slow rate up to the early 1960's. Fishing activities were confined mainly to coastal waters and carried out by non-mechanized boats using traditional methods. The introduction of trawling brought about a rapid technological change. Within a short time, fish catches had increased several-fold and most of the national catch was being taken using modern methods. The fishing industry began to play an increasingly important role in the national economy. Today the Thai economy is a mix of agriculture, manufacturing, mining, and tourism. Fisheries is included under the Ministry of Agriculture and Cooperatives, so that in macro-economic considerations, fisheries is included as a subsector of agriculture, and is included in the latter's statistics. Agriculture, both in terms of primary production and agro-industry, remains the backbone of economic activity, accounting for nearly 70 percent of the workforce. However since 1985 — according to Government sources — manufacturing has taken over as the largest contributor to GDP.

In a relatively short period, over the last decade or so, the Thai fishing industry has grown rapidly to become the fourth largest in Asia (after Japan, China, and India), with export earnings totalling about U.S. $750 million in 1985. Fish products rank among five top income earners in Thailand. In 1983, Thailand ranked seventh in the world in value of fish product exports. Table 1 shows the volume and value of Thai international trade in fish and fish products from 1970 to 1985.

Accurate statistics on total employment in the fisheries sector are not available. Preliminary results of a marine fishery census conducted in 1985, focussed on households rather than individuals. Table 2 contains the most salient data reflecting the preliminary results of the census. It may be estimated that employment onboard fishing boats alone is in the order of 200 to 250 thousand persons. The processing sector (including freezing, canning, and pre-processing steaming and peeling/shucking) of the larger entreprise type, may be employing some 40 to 50 thousand persons, primarily women. Traditional processing, on the cottage industry scale, gives employment to additional thousands of women.

The shore-based activities directly related to fisheries are highly decentralized and several small operators participate in various phases of the movement of fish from boat to the customer. Many are family operation employing only family members, including school-aged children. Other small enterprises provide employment to hired labour as well.

The industrial type processing establishments (canneries, freezing plants, etc.) have developed in response to world demand for seafood either available in Thailand, or produced here cheaper than elsewhere. The domestic supply of fish and fish products goes through traditional channels and establishments much smaller in scale than those processing for export. Government policy strongly supporting free enterprise, favours the initiative of individuals who make their living dealing in fish directly or indirectly. The shorebased operations/flow channels of fish constitute a complex web of often highly specialized entrepreneurs, who make money on the operations but at the same time give employment to thousands of people.

The Thai fishing industry then, is a major contributor to the national economy. The Government attaches great importance to the industry and is determined to upgrade the weaker segments in it.

Table 1. Thailand: International trade in fishery commodities

Year	Imports		Exports	
	mt	US$'000	mt	US$'000
1985*	152,707	154,298	466,219	741,106
1984*	119,064	88,305	411,722	646,738
1983	58,562	42,821	336,076	544,039
1982	45,948	28,206	308,378	482,012
1981	46,947	22,223	313,351	412,451
1980	43,530	23,378	268,965	358,259
1979	79,938	20,996	284,423	362,760
1978	29,183	8,608	239,429	252,895
1977	18,575	6,682	181,107	176,783
1976	24,868	7,248	131,774	150,378
1975	19,682	6,260	97,998	105,361
1974	19,965	4,667	88,221	77,449
1973	19,542	4,628	104,133	82,496
1972	15,139	4,185	82,381	38,608
1971	...	...	54,500	23,996
1970	...	...	44,100	17,656
Average Growth Rate				
1976/1985	22.3%	40.5%	15.1%	11.2%
1970/1985	...	...	17.0%	28.3%

* 1984 and 1985 preliminary data

Source: 1976 - 1983 FAO Yearbook of Fishery Statistics, Vol. 59.
Remaining data: Department of Fisheries, Bangkok.

Table 2. Summary of results of census of marine fishery — 1985

1. Number of households by types of fishery & status — total number of households	84,401
— capture fishery	49,877
— capture fishery & coastal aquaculture	1,801
(subtotal: Capture & capture & culture)	(51,678)
— coastal aquaculture only	5,848
— fishery employees' households	26,875
2. Number of fish dealers — total	4,637
a) local fish dealers	
— wholesalers	1,501
— retailers	2,584
b) non-local fish dealers	
— selling mainly at the Bangkok market	208
— selling to markets other than Bangkok	344
3. Number of fish processing households — total	14,184
a) by type of management	
— operators' households	13,979

Table 2. (continued)

— company	205
b) by type of engagement	
— processing only	6,342
— fishing & processing	7,842
c) by type of activity*	
— freezing	3,956
— canning	28
— fermenting	4,733
— steaming	1,723
— smoking	53
— fish/shrimp balls & crackers	211
— salting/drying	4,150
— reduction	109
— other forms of processing	488
4. Number of households with or without boats	
— total	51,678
— with boat	48,311
— without boat	3,367
5. Number of fishing boats by type of boat — total	53,440
— non-powered boats	8,302
— outboard engine	28,233
— inboard engine	16,905
6. Number of coastal aquaculture households by type of activity**	
— fish culture	1,710
— shrimp culture	4,504
— crab culture	184
— oyster culture	1,197
— sea mussel culture	265
— blood cockle culture	123
— horse mussel & other	11

Source: Preliminary Report, 1985 Census of Marine Fishery, National Statistics Office.

* Figures do not add up to total due to multiple activities.

** Figures cannot be summed up due to multiple activities undertaken by one household.

Fishery Resources

The maximum sustainable yield (MSY) of marine resources in Thai waters is estimated to be 1.2 million tons, of which demersal fish comprise 970,000 tons and pelagic fish 230,000 tons. In the Gulf of Thailand and the Andaman Sea, fishing in excess of the estimated MSY has been pursued for many years. The stocks, particularly of large fish species have, as a result, declined sharply.

The declaration of 200 mile exclusive economic zones (EEZ) by neighbouring countries has further aggravation the problem, since Thailand has lost access to about 40 percent of the fishing grounds exploited prior to the introduction of EEZ. This, coupled with rising domestic demand and exports has forced fishermen back to the already overfished Thai waters. Joint venture agreements and licenses to fish in foreign waters could only partly offset the losses.

A mission which advised the Royal Thai Government on implications of EEZ for the Thai fishing industry estimated that Thailand may lose, as a result of the new legal regime of the sea, between 300,000 and 600,000 metric tons of fish annually. From a perspective of the past ten years that estimate has to be considered realistic. Among measures to counterbalance the losses in production, the mission recommended the reorientation of the work of the Fish Technology Division of the Department of Fisheries towards utilization of "trash" fish and non-traditional fish species for human consumption, and towards upgrading the quality of fish products, through improved handling and processing techniques.

Trawling and other modern fishing methods, accompanied by motorization of fishing boats and the gradual introduction of new types of fishing vessels resulted in an accelerated development of the industry. The predominant focus of the industry was on growth in the volume of landings, while the quality of fish landed and distributed through the complex distribution/trading network was of secondary concern and thus has not kept pace.

The pace at which the Thai fishery grew is illustrated in Table 3. The most rapid growth, averagin 17.3 percent per annum, took place during the decade 1962 — 1972. Heavy fishing within Thai waters, and the first results of the introduction of EEZ by neighbouring countries, combined with considerable fluctuation in aquaculture output, have resulted in a decline in total catch in the mid-1970s. The subsequent decade witnessed a comparatively modest average growth rate of 2.4 percent per year, and since 1982 growth has been arrested. It is unlikely that the marine fishery will be able to increase its production, due primarily to limitations of access to resources in foreign EEZ's.

Table 4 shows developments in the fishery — both marine and inland, between 1975 and 1985. It should be noted that the increase in total landings since 1977 was largely a result of the successful initiatives of the Government and the industry in negotiating fishing rights in foreign EEZ's.

The fluctuations in the marine nominal catches since that time are the result of not only changes in yield from Thai waters, but also of changing fortunes of joint ventures or access to fishery resources in foreign EEZ's.

Utilization of Fish Landed

The composition of marine fish landings in Thailand is typical of a tropical fishery, with a few species recorded separately and the bulk of landings composed of a mix of many species. Table 5 illustrates this, showing the species composition of marine fish landed. It will be noted that over half of the total landings of food fish is classified as "other" since it is composed of smaller quantities of several species.

Table 3. Growth rates of Thai fisheries

Year	Landing (mt)	Average Annual Rate of Growth Year : Year	%
1955	213,000		
1962	339,700	62 : 55	6.9
1965	615,100		
1972	1,678,900	72 : 62	17.3
1975	1,552,800		
1982	2,120,000	82 : 72	2.4
1985	2,124,400	85 : 82	0.07

Table 4. Nominal catches 1975 — 1985 (mt)

Year	Total	Marine	Inland	% of Total Marine	% of Total Inland
1985	2,124,400	1,958,800	165,600	92.2	7.8
1984	2,134,838	1,973,019	161,819	92.4	7.6
1983	2,249,808	2,099,808	150,000	93.3	6.7
1982	2,120,021	1,986,459	133,562	93.7	6.3
1981	1,988,650	1,824,069	164,581	91.7	8.3
1980	1,792,030	1,647,035	144,995	91.9	8.1
1979	1,944,202	1,811,026	133,176	93.2	6.8
1978	2,097,492	1,956,486	141,006	93.3	6.7
1977	2,188,492	2,066,118	122,374	94.4	5.6
1976	1,659,388	1,512,094	147,294	91.1	8.9
1975	1,552,836	1,392,144	160,692	89.7	10.3
Average Growth Rate	3.2%	3.5%	0.3%	—	—

Source: 1975 — 1983, FAO Yearbooks of Fishery Statistics.
1984 and 1985, Department of Fisheries, Bangkok.

Table 5. Marine fish landings — major species 1981 — 1984

		1984	1983	1982	1981
A. Total Landing	— '000 mt	1973.0	2100.0	1986.6	1824.2
of which:					
food fish	— '000 mt	1215.4	1296.7	1173.8	1027.7
	— % of total	61.6	61.7	59.1	56.3
"trash" fish	— '000 mt	757.6	803.3	812.8	796.7
	— % of total	38.4	38.3	40.9	43.7
B. Major Species	— '000 mt				
Indo-Pacific mackerel		129.1	79.8	86.1	71.7
Indian mackerel		33.4	53.2	21.5	20.5
Shrimp		136.2	160.3	187.4	148.2
Shellfish		153.6	115.6	157.2	154.3
Cephalopod		129.3	132.0	116.6	80.8
Other food fish		633.8	755.8	605.0	552.2
(Tuna-like fishes within "other")		(51.8)	(51.8)	(49.3)	(22.3)

Source: Fisheries Record of Thialand, 1984, Department of Fisheries.

Note: Line — "Tuna-like fishes" from FAO Yearbook of Fishery Statistics, Vol. 58.

"Trash" fish continuously comprises about 40 percent of total landings, and it comes basically from trawlers. It includes small, low value species, used predominantly for reduction to fish meal, and by catfish and duck farming enterprises. Onboard, this fish is kept in holds in bulk, virtually without ice. Unloading from larger trawlers is also in bulk, straight onto trucks for delivery to reduction plants or farms.

Since the market for trash fish is extremely good, either as direct feed or as raw material

for reduction, and the prices are rather high, the vessel operators do not have sufficient incentives to try and recover fish which could be used for direct human consumption or as raw material for processed food products.

It is not known whether the small fish constituting the bulk of the "trash" fish are full grown or are juveniles of species which can grow to a larger size. This aspect is particularly important from the viewpoint of resources management, on which the future of the national fishery may depend.

Table 6 indicates the utilization of fish and the changes in utilization patterns which have taken place since 1970.

It is evident that the proportion of fish marketed fresh has decreased from 47 percent in 1970 to 26.3 percent in 1984. The absolute volune of fish marketed fresh has also declined considerably. Freezing is rapidly gained importance. This is primarily due to exports. Canning, non-existent in the first half of the 1970's, now absorbs almost 9 percent of the total fish supply from national landings.

The volume of raw material utilized for cured fish products varies from one year to another, as does the percentage share of that group in total landings. Curing is often the processing method of last resort, utilizing fish which is unsuitable for other purposes, either because of its quality/freshness or because of its small size.

The post harvest losses of fish in Thailand like in other Asian countries are negligible. Fish classified unsuitable for direct human consumption is either cured viz fermented and used for instance as sauce, or reduced to fishmeal.

The increase in modern processing of fish for export, and the continuing high proportion of trash fish in local landings, however, pose serious problems to the supply of food fish to the domestic market and its national per capital consumption.

The Fish Processing Industry

As discussed under "Utilization of Fish Landed", only 26 percent of fish landed is marketed fresh or chilled, while almost three-quarters of the landings are processed in one way or another. A major portion of the landings (approximately 40 percent) is reduced to fishmeal. Freezing, canning, and curing jointly absorb more then 34 percent of the national landings. It is recognized that the canning industry imports increasingly larger quantities of tuna for processing in Thailand. Imported fish is not included in the fish utilization statistics. Table 7 lists the numbers of fish processing establishments registered in 1984 broken down by type of production.

Table 6. Utilization of fish

	1984		1980		1974		1970	
	Tons	%	Tons	%	Tons	%	Tons	%
Marketed Fresh	560,900	26.3	590,400	26.2	600,000	36.9	680,500	47.0
Frozen	201,000	9.4	155,600	6.9	65,000	4.0	21,000	1.5
Cured	346,700	16.2	526,800	23.4	223,000	13.7	204,900	14.1
Canned	181,300	8.5	116,300	5.2	0	0.0	0	0.0
Other	844,900	39.6	866.300	38.4	740,000	45.5	541,200	37.4
TOTAL	2,134,800	100.0	2,255,400	100.0	1,628,000	100.0	1,448,400	100.0

Note: Percentages may not add up to 100 due to roundings.

Line: "Other" indicates fish used primarily for reduction/animal feed.

Source: Department of Fisheries, Thailand.

Table 7. Thailand: Fish processing establishments 1984

	Number of Plants	Capacity	Total Annual Production*	% of Total Fish Producessed	Production Tons/Plant (Annual)	Production Kilograms/Plant/D 300 Days/Year
1. Cold Storage	78					
— freezing capacity: tons/day		1,991				
— storage capacity: tons		49,746				
— actual throughout: tons			200,240		2,567	8,557
2. Ice Plants — cube ice (boxes)**	152		23,508,939		154,664	
— flake ice (tons)	3		214,940		71,647	238,822
3. Canneries	38		264,557	19.4	6,962	23,207
4. Fish Sauce	113		24,227	1.8	214	715
5. Fishmeal	95		881,518	64.8	9,279	30,930
6. Shrimp Paste	2,860		14,558	1.1	5	17
7. Salted Fish	800		59,863	4.4	75	249
8. Dried Shrimp	284		42,800	3.1	151	502
9. Dried Squid	865		46,833	3.4	54	180
10. Dried Mussel	776		7,884	0.6	10	34
11. Steamed Fish	138		10,812	0.8	78	261
12. Smoked Fish	184		2,925	0.2	16	53
13. Fish/Shrimp Crackers	78		886	0.1	11	38
14. Fish Balls	64		3,467	0.3	54	181
15. Budu Sauce	37		428	0.1	12	39
Total Tonnage of Raw Material (— Fish)			1,360,758	100.0		

Source: Statistics of DOF, Bangkok.

* Production of fish processing establishments expressed in tons of raw material.

** Production of cube ice expressed in boxes, as reported in official statistics.
Production per plant/day at 300 days a year is a hypothetical throughput of raw material per day to illustrate the small size of certain processing establishments.

Cold Storage and Freezing Facilities

A total of 78 plants with an aggregate daily rated capacity of 1,991 tons of freezing, and cold stores for 49,746 tons were in operation in 1984. All plants are owned by private interests, with the exception of those few owned by the Cold Storage Organization (CSO).

Although there are no statistics on the utilization of freezing capacities, they may be considered more than adequate (Table 8), despite seasonal variation in daily landings. Freezing plants are probably not utilized to capacity even during peak season.

The annual throughout of cold storage facilities of 200,240 tons as compared to capacities gives an average rotation ratio of 4, again reasonable, and perhaps leaning towards underutilization. Production of ice also seems to be adequate for the annual catch; however, seasonal variations in landings and the hot season may require more ice than available from daily production. Reports by various fish handling and processing specialists confirm that premium quality fish, viz high value species, are always well packed and iced. The use of ice seems to be determined by the ex-vessel price of fish rather than its availability.

Canneries

Total exports of canned seafood in 1985 were 132,489 tons, an increase of 3.2 times over 1981. Canned products have become the most important group of fish export product. The most notable feature of this industry has been the rapid increase in the production and export of canned tuna. Canned tuna in 1985 constituted 66 percent by volume and 63 percent by value of canned seafood exports; at the same time it constituted 25 percent of total exports by value. Tuna landings from the national catches are not sufficient to supply the canning industry and therefore imports of tuna are growing rapidly. The 1985 imports of fish totalled 152,707 tons, composed largely of raw material for the canning industry. It is estimated that in 1986 imports of tuna will reach 250,000 tons; in 1983 this was below 40,000 tons.

Table 8. Export of fish and fish products, by major product groups

	1981		1982		1983		1984		1985	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Total exports	**313,351**	**8,756**	**308,378**	**11,231**	**336,076**	**12,677**	**411,722**	**15,081**	**466,219**	**18,528**
Frozen shrimp	19,699	2,081	22,647	2,764	20,150	3,165	19,428	2,799	24,041	3,439
Frozen cephalopods	39,000	1,248	42,656	1,784	39,321	1,637	42,821	1,693	46,289	2,121
Fishmeal	111,042	968	83,074	701	93,246	785	85,487	743	74,791	605
Crustacean and molluscs meal	20,289	327	20,713	377	34,761	579	43,825	764	53,673	1,000
Fresh & frozen fish	49,000	530	53,116	688	53,409	686	75,254	1,017	96,444	1,377
Dried cephalopods	2,900	450	3,565	607	3,440	630	3,918	800	4,386	1,045
Dried shrimp	1,976	180	2,217	216	5,524	448	6,234	551	5,925	532
Canned seafood*	40,848	2,092	65,770	3,186	74,391	3,968	110,491	5,862	132,489	7,347
of which:										
— tuna	—	—	—	—	n.a.	n.a.	39,862	1,854	87,134	4,620
— crustaceans and molluscs	—	—	—	—	24,437	1,847	29,047	2,162	29,542	2,142
— sardines	—	—	—	—	n.a.	n.a.	2,412	60	3,012	92
Other fish products	28,597	880	14,620	908	11,834	779	24,264	852	28,181	1,062

Source: Department of Fisheries

Note: *Statistics on exports of canned tuna prior to 1984 are not available

Quantity: mt; Value in million Baht

In 1984 there were 38 registered canneries with major concentrations in Samut Prakan (11 plants), Samut Sakhon (8 plants), and Bangkok (7 plants). The total production of canned seafood for that year was 110,491 tons, for which 264,557 tons of raw material were used. Data regarding capacities of the individual plants are not available; however, the average annual throughout of raw material was in the order of 7,000 tons. The canning industry produces mainly for export, and most of the canneries were constructed recently. The modern canneries are built to international standards.

Initial processing of many species eventually used by the modern canning plants is carried out at various places outside the plants, and pre-processed raw material is then purchased by the canneries. Such initial processing is carried out in peeling sheds, shucking stations, market floor, houses, or any other available space, even on the street. Small shrimps are peeled raw, or cooked and then peeled; crabmeat is picked, cephalopods are cleaned, clams are shucked, and fish are filleted. The products resulting from these operations then become the raw materials for the canning and other processing industries, as well as for plants producing traditional products. These facilities are not registered with any Government agency and are under no formal control. The operational formal conditions are in most cases inadequate. When the canneries and cold storage plants received products from such facilities, quality has already suffered seriously. These facilities are an impediment to achieving good quality products and seriously affect the quality of canned and frozen products for export.

Processing of Traditional Products and Pre-processing

As may be seen from Table 7, of the total fish processed some 15.8 percent were used for what is called "traditional products". The most important among these (in terms of raw material used) are salted fish, dried squid, dried shrimp, and fish sauce. Some of these products are also exported, however the bulk is marketed domestically.

The number of processing establishments officially reported by the Department of Fisheries was 6,199 in 1984, and the amount of raw material processed was 214,683 tons, giving an average of 34.6 tons per operator. Table 7 gives the average annual production in terms of raw material, by type of products. Since details on the processing establishments producing traditional products are not available, a calculation has been made in Table 7 showing daily production, assuming that these establishments operate 300 days per year. Although this calculation may not accurately reflect the number of

production days (affected *inter alia* by weather conditions or fishing season) it does provide an impression of the average size of the processing establishment. It is clear that virtually all traditional products are manufactured by what could be defined as "cottage industries." Daily raw material throughout per establishment ranges from 17 kg in the case of shrimp paste, to 715 kg for fish sauce. Establishments producing salted fish and dried squid and shrimp used between 180 kg and 502 kg of raw material daily.

The scenario painted above is only part of the overall fish processing scene in Thailand. The recent Census of Marine Fishery of 1985, the results of which are summarized in Table 2 showed that in the coastal areas alone there were 14,184 "fish processing households," of which there were 13,979 "operator households," and 205 company-type operations. The difference between the official statistics and the census is significant and indicates that only a percentage of the processing establishments in existence are recorded regularly by the respective Government Agencies.

Furthermore, it would seem that the entire operation of pre-processing, on which the canning industry depends for raw material, is not fully reflected in the official statistics. The number of processing establishments, as reflected in the census summary, shows the importance of the processing operations from the point of view of employment. The processing and pre-processing operations are largely based on the principles and practices of small business, i.e., the operators buy fish, process it, and resell it to canneries. Some pre-processing is done by fishing families, which in addition to providing a livelihood for thousands of families, is also a traditional activity.

Fishmeal Plants

There were, according to official statistics, 95 fishmeal plants in 1984, with major concentrations in the provinces of Samut Prakan, Samut Sakhon, Chumphon, Nakhon Si Thammarat, and Songhkla. Their production capacity is not available; however, the production in terms of raw material was estimated to be 881,518 tons. The fishmeal industry grew from 25 plants in 1970 to 99 plants in 1981, but the number declined in recent years. The principal source of raw material was trash fish, with a small percentage of sardinella and anchovies.

Throughput of raw material averaged 9,279 tons per plant in 1984, viz an average daily production of some 31 tons, assuming 300 days of operation per year. Variations in throughput ranged between 1970, when it reached 35 tons per day, to a low of 22 tons per day in 1982, indicating that capacities are not fully utilized.

The quality of the finished product is below international standards. Protein is reported to be often below 60 percent, ash content at 22 to 35 percent, and sand content 3 to 5 percent. These characteristics are largely the result of the quality of the raw material. Product quality suffers from the fact that many of the fish are delivered in a partly decomposed condition.

In addition to fishmeal, meal made from crustaceans and molluscs constitute an important part of the total output. In 1985 it comprised 42 percent to total meal exports. Fourty to 50 percent of fishmeal produced is consumed locally; the rest is exported mainly to Malaysia, Singapore, and Indonesia.

The industry incurs losses in protein and weight (yield) of the final product due to poor handling of the raw material at sea and ashore. Improvements in this field would result in considerable economic gains for the industry.

Export of Fishery Products

In 1987 Thailand ranked seventh, in terms of value, among the worlds' fish exporting nations, after Canada, USA, Norway, Denmark, Japan and the Republic of Korea. Three years earlier, in 1981, Thailand was eleventh, behind countries listed above and Iceland, The Netherlands, Mexico and Spain. Thailand has become a major processor of fish relying to a large extent on imports of raw material. In global terms, disregarding individual species and products, Thailand's 1985 exports converted to round weight of fish are comparable to around 50 percent of the annual national catch. Table 8 shows that the volume of growth between 1981 and 1985 was of the order of 50 percent, the value of exports — in local currency — grew more than two-fold.

A remarkable shift has taken place in the structure of export commodities, from products with a lower value-added component, towards products of high value. The processing industry has depended on cheap

labour available in Thailand and exploited structural changes taking place in the world fishing industry and the international trade in fish and fish products. The most spectacular growth occured in cephalopods and most recently in canned seafood, particularly tuna. It is expected that in 1986 exports of canned tuna will exceed the 100 thousand tons mark.

The present status and future outlook of the tuna, cephalopod, shrimp, canned shrimp, crabmeat and clam and dried fish components of the industry is briefly described below.

Tuna

Official statistics regading Thai exports of canned tuna prior to 1984 are not available. However, the industry estimates that in 1979 exports were in the order of 3.2 thousand tons; in 1980 — 4.6 thousand tons; in 1981 — 12.6 thousand tons; in 1982 — 17.5 thousand tons; and in 1983 — 28.6 thousand tons. In 1985 exports reached 87.1 thousand tons, the equivalent of 8.5 million cases.

By 1985 Thailand become the largest canned tuna exporter in the world. Already in 1983, Thailand replaced the Philippines as the largest tuna exporter to the United States of America, by far the largest canned tuna market in the world. The following year Thailand increased its exports to the United States further and also consolidated its foothold in the European markets.

One of the most interesting aspect of Thailand's success in the industry is that it has emerged as the largest canned tuna exporter in the world without having a large tuna fishery of its own. Thailand is almost completely dependent on frozen tuna imports to sustain its processng operations. Yet it has been able to maintain supplies and increase its canned tuna production at a time when international market was in recession. Skipjack, yellowfin and albacore are imported from Japan, Taiwan, the US, Maldives, Papua New Guinea, and the Solomon Islands. Long-term contracts on raw material procurements up to a 12-month period are arranged to ensure continuous supplies for the production lines.

The development of the tuna canning industry in Thailand is largely the result of the world's situation, of which the Thai fish processing sector has availed itself so successfully. The world tuna industry has not recovered from the recession which took hold in 1981. Measures which were initially taken to deal with the situation have resulted in a major restructuring of the industry. Some of the changes include:

— Changed pattern of resource exploitation. The US purse seine fleet moved from the Eastern to the Western Pacific, and the French and Spanish fleets moved from the Eastern Atlantic to the Western Indian Ocean,

— The closure of all but one tuna canning plant in the continental United States and the expansion of offshore operations in the US territories of Puerto Rico and American Samoa, and

— A rise in the canning capacity in low cost producing countries, particularly in Thailand, Mexico and the Philippines.

In fact, US trade groups are concerned about the developments which directly affect the US industry and market. In early 1986 they appealed to the International Trade Commission to conduct a through survey of the tuna industry in the USA, Thailand, Taiwan Philippines, Japan, Mexico and some other countries. The ITC is expected to submit a report to the US Congress by the end of 1986. The outcome of the report may affect US canned tuna import policies and tariffs.

It seems that the changes which were taking place in the tuna industry worldwide have not yet come to an end. The industry is still evolving, and adjustments are continuing to occur. Most observers of the industry agree that the major problems are: (i) excess production and processing capacity relative to demand; (ii) increased competition among high and low cost producer; (iii) market dependence on one single product form ie canned tuna. These problems have surfaced in the early 1980's and have continued to plague the industry despite short term improvements in market prices and tuna consumption worldwide.

Cephalopod

Three groups of cephalopods are of a commercial importance worldwide: squid, cuttlefish and octopus. World landings of cephalopods increased between 1970 and 1984 by some 650 thousand tons from 1.0 million tons in the former year to 1.65 million tons in the latter year. Japan, the Republic of Korea, Spain and China are the main catching nations.

World production is on an upward trend to satisfy market demand. Thailand joined the group of countries traditionally fishing for cephalopods, and its catch in 1984 reached 130 thousand tons.

Thai exports of cuttlefish in 1985 constituted 8.1 percent of the country's total fishery exports by value. By weight, 25.7 thousand tons of cuttlefish were exported, of which 13.9 thousand tons were to Japan. In tonnage terms, exports to Japan constituted 54.1 percent; however in value terms this was almost 77 percent. The second important buyer was Italy, with 6.7 thousand tons constituting 26.1% by weight and 14.2 percent by value. The third important market was France, where 3.3 thousand tons were exported.

The total exports of frozen squid were 11.2 thousand tons, of high two-thirds were exported to Italy. Frozen octopus exports totalled 9.4 thousand tons, of which 4.4 thousand tons went to Japan and 3.4 thousand tons to Italy. The only other meaningful quantity — 982 tons — was imported by Spain.

Thai production and exports of canned cephalopods were negligible, as the international market has a preference for fresh (frozen) product.

Besides fresh and frozen, cephalopods are marketed in many forms: canned, dried, salted, fermented etc. The growth of fresh and frozen products over the last several years has been remarkable. Input for preparations has also shown a steady increase. The quantity cured is on an upward trend, although this form of utilization seems to be quite sensitive to production trends.

Shrimp

World shrimp production reached 1.9 million tons in 1984; Thailand produced 137.3 thousand tons or 7.4 percent of the world's total.

Marine catches are thought to be at or near their upper limit. However, production of cultured shrimp is increasing rapidly, although from a relatively small base. World demand for shrimp remains strong. It is one of the most important products entering the world seafood trade channels.

Canned shrimp

The total 1985 exports were 12.2 thousand tons, sold to: USA — 5,300 tons; France — 2,600 tons; and Canada 1,600 tons. Other importing countries received the remaining 2.7 thousand tons.

In the USA the consumption of canned shrimp was on the decline and it affected the price levels. Besides, its price was adversely affected by poor quality of the products. The market for canned shrimp is very small in relation to that of frozen product.

Canned crabmeat and clam

Clams and crabmeat are not as important in the importers' market as are other products, and the end consumer buys them as a luxury item rather than a "ready meal" item, which is a function performed by canned tuna. It is for this reason that market is unstable and those items are more vulnerable to changes in disposable incomes of consumers.

Dried fish

In many countries drying is the simpliest solution to preserving fish. Drying was the only preservation method over many centuries and a variety of traditional dishes include cured fish products sometimes as condiments, like fish sauce, but often as the main protein source.

Often regarded as poor peoples' food, dried fish has retained its importance in the major producing countries and its production has even increased. Several products have also a good international market. Higher priced speciality items like sharkfins, fishmawas, dried shrimp and dried squid and cuttlefish account for the lion's share of market in this category of products. However, consumers have become more quality conscious and improvements in processing methods and presentation are becoming more important.

In Southeast Asia, value wise, Thailand is the leading exporter followed by Singapore and Malaysia, while Japan, Hong Kong and Malaysia are top importers of various products. Small quantities are exported to Europe, and notably the United Kingdom and the Netherlands.

Thailand's total export of dried products in 1985 exceeded 20 thousand tons. Japan is the leading import market for dried cephalopods, especially cuttlefish and squid. Hong Kong imports a substantial portion of dried shrimps Thailand produced. The average value realized by Thailand from exports of dried cepha-

lopods in 1985 was US$40.19 millions and for dried shrimp US$20.46 millions.

The main problem experienced by exporters of dried products to Japan and Europe is poor quality, originating with the quality of the raw material, but sometimes the result of processing methods.

Problems Facing The Industry

1. Shortage of raw material

We have seen that as a result of the decline of fish production, the demand of the fishery industries could not be satisfied. The shortage of raw material has resulted from:

1.1 Overfishing

The Marine Fisheries Division, Department of Fisheries reported that MSY of the Gulf of Thailand and the Andaman Sea is approximately 1.5 million tons comprising 970,000 metric tons of ground fish and 490,000 metric tons of pelagic fish. Fish production in Thai waters alone has reached the MSY for several years. The catch of economic species has also declined during the same period.

1.2 Declaration of 200 EEZ of neighbouring countries

Thailand has lost access to about 40% of her traditional fishing grounds as a result of the introduction of EEZ. It is estimated that the decrease amounts to 300,000 — 600,000 tons annually.

1.3 Growth of the fish processing industry

The number of fish processing plants has grown rapidly since 1981 especially those producing mainly for export. Factory capacities are not fully utilised. Since marine fish production is in sufficient, cultured species such as shrimps and imported raw materials such as tuna are also used.

2. Quality of fish and fishery products

It is recognized that the quality of the fish before it reaches the market or processor is often poor — this due to poor handling at various stages in the industry.

2.1 Fish handling on board

The method of fishing used influences the quality of the catch and this particularly time for trawlers because catches are usually left on board for long time with small qualities of ice. Low value species additionally suffer from poor bulk storage conditions.

Fish are stowed in ice in containers of various materials and designs. Handling on board is improving gradually, through the introduction of plastic containers.

Chilled sea water storage is done in certain areas by storing fish in 200 l container. Catches are sent to shore by transport boats under the pooling system. As a result, fish are no longer held for the whole fishing days (21 days) and this has improved quality in the catches.

2.2 Fish landing complex and fish market

There are presently 19 major ports which, between them, account for 77 percent of the total marine landings. The Fish Market Organization administers 10 of these fishing ports and three fish markets and there are some private landing jetties. Landing facilities appear to be adequate in terms of capacity, but there are major problems in fish handling methods and sanitation. Although plastic containers have been introduced for unloading the catch and for handling of catches on shore, about 25 — 30% of containers are still of basket and wooden boxes. Lack of clean water for washing fish is a problem at all landing sites. Delay in auctioning is another cause of fish deterioration.

2.3 Fish Transportation

From the landing place, fish is usually transported by truck in bulk or in fish boxes depending on its value. Refrigerated trucks/containers are used to transport raw materials to processing factories. However fish used for traditional or for preprocesing usually travel by open truck. Shrimps, cuttle fish, squid and baby clam are held in fiberglass tanks on trucks. High temperature often cause product deterioration at this stage.

2.4 Processing plants

Most processing factories producing for export are built to international standards.

Local and traditional products are processed by small to medium scale processors who are handicapped by having to use raw materials of doubtful quality. Initial processing is carried out in peeling sheds in which there is seldom any quality control. Moreover because raw materials are limited and competition for raw materials is intense, factories with low purchasing power get poor quality raw materials. Delay in processing also aggravates quality problems. In-plant quality control exits but needs upgrading including the training of staffs.

3. Technology

Production of traditional products is still labour-intensive and dependent on the environment. Product quality leaves much to be desired and education in quality control is needed.

Export production depends heavily on imported technology and equipment and expertise on certain production methods is hard to come by. There is a need to develop technology that suits local raw materials, conditions and markets. Factory production and quality control staff need training to keep up with market requirements.

4. Rejection of Thai Fish Exports

Thai seafood exports are handicapped by a poor reputation. Handling practices at sea, on the landing jetties, and during processing are frequently not up to international standards. The result is frequent rejections and generally lower prices.

Official rejection figures more over take no account of quality problems which were negotiated (almost always with an attendant loss in value) after passage of goods from exporter to the importer. The problem of rejections grew as development of the export trade accelerated.

The main reasons for rejections of canned and cured product were animal filth and decomposition, while frozen shrimp was contaminated with *Salmonella*. It is not surprising, bearing fish flow channels in mind, that canned clams, shrimp, and crabmeat were contaminated with animal filth, or were even decomposed. Surprisingly, however, canned tuna also suffers from that problem, despite the fact that the raw material does not go through preprocessing typical for crustaceans and shellfish.

Most fish processing plants, especially the newer ones, operate their processes to recognized standards. The raw material received for processing, particularly that originating from local boats, is already contaminated soon after catching or, more often, in preprocessing. Fish inspection and quality monitoring services of the Department of Fisheries are extremely limited and confined mainly to Bangkok. Sanitary certification of plants is done voluntarily. Many types of export certificates are involved, and there is a lack of clearly defined lines of authority between the various Government agencies for their issuance. This is administratively confusing and technically unsafe. A virtual lack of fish inspection in Thailand, and absence of minimum quality standards are the main obstacles to upgrading the quality of final products, whether for the domestic or export markets.

Quality control is essential for the success and healthy development of the fishery industry producing for exports. Improved quality of raw material may result in higher yields, lower operating costs, greater market acceptability, and increased profits. There is a direct relationship between quality control and profitability.

Role of Government in Upgrading the Industry

The Department of Fisheries has full responsibility for fisheries research and development. The Fishery Technological Development Division (FTDD) is the technical arm responsible for developing fisheries postharvest technology. Its main activities include the upgrading quality of fish and fishery products and maximizing utilization of marine, brackish and freshwater fish. Since 1968, the Division has carried out research and development on methods of handling, distribution and promotion of technical improvements leading to better quality in fish and fish products, both traditional and conventional. The Division also promotes new product development and the design of low cost fish processing equipment. In the early 1980's, the Government inaugurated its 5th National Social and Economic Plan for poverty eradication. The division has made its goal in the Plan utilization of low value fish for human consumption and the use of fish and fish products to alleviate malnutrition.

Since 1985, Thailand has been anxiously looking for increased exports and improved foreign exchange. This calls for new initiatives and efforts in the area of product development, value added products and improvement of quality of exported goods and standard of fish processing plants. The Division has expanded the work on quality control to cover plant inspection, product inspection and product certification as well as research and development. Transfer of technology has became one of its major activities with training and seminars provided at all levels from fishermen and villagers to processing plant managers,

quality control personnel and also consumers. The seminars focus on the production, utilization and quality control of fish and fishery products. The upgrading of technical competence, facilities and services is done in cooperations with the international institutes such as SEAFDEC, International Development Research Center (IDRC), Canadian International Development Agency (CIDA), Food and Agriculture Organization (FAO), Australian Development Aid Bureau (ADAB), ASEAN Food Handling Bureau (AFHB) and INFOFISH, and with local and foreign universities.

The FTDD has been particularly active and successful in upgrading the technological level of small-scale and export-oriented factories. This has been achieved through the promotion of good manufacturing practice. This link with the private sector facilitates communication and exchange of information and has contributed to the identification of problems of industrial importance, and their probable solution.

Fish Marketing Organization (FMO), a state enterprise within the Ministry of Agriculture and Cooperatives, is another body actively involved in fisheries post-harvest activities. FMO provides, on behalf of the Government, the essential infrastructure for fish marketing such as ports and wholesale market. The organization is also responsible for the maintenance and operation of fishing harbours and fish auctions, monitoring the activities of fish agents and giving them assistance. Furthermore, FMO is empowered to encourage the establishment of fishermen's cooperatives and associations and to support their activities. In cooperation with the Department of Fisheries, FMO has improved the handling system at fish markets and landing complexes by introducing the returnable container system and providing handling equipment at major fish landing complexes and fishermen cooperatives. Further work on upgrading the quality of fresh fish under the inspection and quality control program will be initiated in major fish markets.

Universities have provided the industry with graduates in Food Science, Food Technology and also Fishery Food Technology. Six universities now offer courses in these fields.

Others government institutes with active roles in fisheries post-harvest technology are the Department of Medical Science, the Food and Drug Administration, the Thai Industrial Standard Institute and the Ministry of Industry. These institutes have authority to control sanitation, processing methods and food processing plants in general. The Department of Medical Science also issues Analysis Certificate and Health Certificate for all kinds of food.

Government institutes concerned with the industry support the private sector at all levels. It is realized that neither Government nor the private sector alone can achieve quality improvement of raw material and products. Closed collaboration is needed.

Government bodies also mediate between government institutes of importing countries and exporters.

Future Development

The Government of Thailand's Sixth National Social and Economics Plan (1987-1991) focuses on poverty eradication, export promotion and financial stability of the country. The Plan emphasizes diversification of production and the fisheries sector is seen as an area with good opportunities for development especially through culture of shrimp and fish. Development of value-added and quality products is also being encouraged.

The Department of Fisheries is involved in working toward the goals of Sixth National Social and Economic Plan. Priority has been given to increasing the export of high value fishery products and to promoting further development of fisheries. This is being done to help alleviate the country's trade deficit while at the same time creating additional employment especially in rural areas. Fishery product development, especially using low valued species is viewed as an important means of increasing the supply of protein for human consumption.

To accomplish the above goals, the following activities are planned:

1. Increased production through expansion of agriculture and joint venture fisheries.
2. Upgrading of the quality of fish and fishery products.

Quality improvement requires close collaboration between government agencies and private sectors, supporting infrastructure and well trained staffs to follow up the work and is therefore, a time consuming program. To

achieve this an inspection and quality control program acceptable to government and private sector should be implemented.

3. A strengthening of capabilities in fish handling and processing, including the following:

3.1 Upgrading of facilities and widened study in:

- The utilization of low value fish, production of marketable value-added products and the upgrading of quality of traditional products,
- Develop processing technology for local species, and
- Packaging technology for fishery products.

3.2 Specialized training of staffs in order to cope with fish handling and processing problems in the following areas:

- Grading of product quality/quality determination, and
- Production technology on freezing, canning, minced fish, dried/smoke fish etc.

Competent staffs must be trained to specialize in depth in certain area to address specific problem faced by industry.

3.3 Technical assistance and training are required to maintain the above activities.

Quality improvements will not come from regulation alone. All parties concerned in fishery industry have to be educated, trained or made aware of raw material and product quality. However, the private sector needs competent technical assistance from government.

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Discussion of Country Reports

DISCUSSION OF COUNTRY REPORTS

"Development of Fish Products in Indonesia"

On the question whether there is any difference between fish meal for human consumption and ordinary fish meal Dr Sunarya explained that the difference is in the quality of the raw material; it should be suitable for human consumption and the product is more hygienically prepared.

Dr Prasert of Thailand noted that Table 1 of the paper suggested a decrease in output of fishery products over the years. Dr Sunarya explained that there had been an actual increase in salted fish and boiled fish production. There had also been a conversion from one product to another and an increase in consumption of fresh fish. The reason for low per capita consumption of fish in Jogjakarta could be that historically it was a princely province where royalty preferred meat to fish.

Concerning distribution of fishing ports in Indonesia, Dr Sunarya replied that most fish landing areas are outside of Java and most of the shrimp trawl by-catch is discarded at sea. The many islands and remote fishing villages made it difficult to collect by-catch to develop the fishmeal industry. High transportation cost is the main constraint in developing the fish silage industry.

Asked whether shrimp is being frozen on board, Dr Sunarya replied that this is not widely practised in Indonesia because of costs and manpower problems. However, attempts are being undertaken to develop this area.

Dr Sunarya also mentioned that studies are in progress on producing shark surimi. The main obstacle is the high urea content.

It is noted that Indonesia covers a vast area, and inconvenient transportation facilities will be the most difficult obstacle to improving fishery products for domestic consumption.

"Present Status of Fish Processing Activities in Malaysia"

On the subject of assistance to the Government of Malaysia in training local private sector clients, the Chief of MFRD (Hooi Kok Kuang) reiterated that there were several types of training courses available in MFRD. MFRD was also in the process of producing training manuals which member countries could use as materials for conducting their own training courses.

Regarding preservation of fish quality on board, Mr Hazizi replied that the amount of ice used varies with the species caught. For high value fish a lot of ice is being used. A lower ratio of ice to fish is used for less expensive species. However, most of the fish caught are small pelagic species which fetch a low price. In this case, refrigerated seawater is being recommended, as it is cheaper, time saving and the price of ice is increasing.

"The Fish Processing Industry in the Philippines: Status, Problems and Prospects"

Professor Matsumoto asked whether, with an increase in processed fish products, the Filipino population were likely to consume more of these products, given their preference for fresh fish; Ms Camu replied that consumption of processed fish is on the increase.

Mr Tan asked whether fish noodles are still in the experimental stage in the Philippines or whether they are a marketed product. Replying that noodles are in fact on the market, Ms Camu explained that the Philippino product comprises 80% fish meat and 20% flour. Dr Prasert commented that in Southern Thailand fish noodles had been on the market for many years but they need to be improved for the central Thailand market.

Mrs Pongpen asked whether smoked fish products are for local consumption or for export markets and whether there is any problem in packaging. Ms Camu answered that smoked fish products are mainly for local consumption with smaller quantities for export markets. Problems were encountered in packaging with moulds growing after 3-4 days but this has been overcome by using potassium sorbate.

"Fish Processing in Singapore"

The country report of Singapore was presented. There was no discussion.

"Improvement in Fisheries Post-Harvest Technology in Thailand"

Asked about the main projects of Fishery Technological Development Division (FTDD) in Thailand, Mr Udom listed:

(a) development of value added products which also covers techniques for producing imitation crab meat,

(b) research and development in traditional products,

(c) upgrading quality and standards of fish and fish products for domestic and export markets, and

(d) certification of export products for overseas markets.

Professor Matsumoto asked whether all minced fish products are frozen or whether some are consumed fresh. Mr Udom said that minced fish products are used in their fresh form for production of products such as fish balls. Daily production of the latter in Thailand is from about 150 tonnes of raw materials. The minced fish is also used for producing surimi for export.

GENERAL DISCUSSION OF COUNTRY REPORTS

To generate discussion on constraints to developing post harvest technology in the region, the Chairman requested that each country itemize the major constraints facing them under the following headings:

a) Fresh fish handling,

b) Traditional products,

c) Fish products for export,

d) Utilization of available resources for direct human consumption, and

e) Training.

Participants from each country duly reported to the Chairman as follows.

Indonesia

a) Potable water supply should be increased. Lack of low-priced ice (efficient machinery should be used).

b) Small scale and simple technique should be developed.

c) Improved technology should be developed in order to increase efficiency.

d) Minced meat/surimi and fish meal for human consumption need to be studied in terms of application by the processor and for economic viability.

e) Training for the private sector is needed.

Malaysia

a) 1. Insufficient supply of ice in some parts of the country.
   2. Price determination of fish by the dealers for each species, rather than quality.
   3. Problems of marketing & distribution.
   4. High investment cost for ice-making plants.

b) 1. Processors' low capital investment.
   2. Processors' low level of education.
   3. Localised product acceptance.
   4. Lack of commodity standards for products.
   5. Inconsistency of raw material quality.
   6. Geographical concentration of processing factories.

c) 1. Problems of sanitation/hygiene of factories.
   2. Standard/quality of products.
   3. Specific products confined to certain export market eg, *Penaeus* prawn for Japan.
   4. Seasonal supply of raw materials.

d) 1. Preference of consumers.
   2. R & D for new products.
   3. Transportation in rural area.
   4. Marketing system.

e) 1. Limited training facilities/overlapping.
   2. Lack of experienced staff.
   3. Insufficient funding.
   4. Lack of coordination among the many government agencies.

Philippines

a) Lack of facilities and other infrastructures; poor fish handling practices.

b) Lack of standardized procedures in processing traditional fishery products; poor hygiene and sanitation.

c) Slow transfer of appropriate technologies; lack of facilities and quality consciousness on the part of fish processor.

d) Lack of capital, facilities, technology and market information.

e) Lack of training facilities in the regions and reluctance of trained processors to share and apply information and knowledge gained in training.

Singapore

a) Proper handling practices are applied only to high value fish.

b) Small scale operations; limited capital to upgrade processing methods.

c) Quality of raw materials, mainly imported, is inconsistent. Raw material supplies to the industry fluctuate in quantity.

d) Local fish production is insufficient to meet the demand of the consumers. Most fish are consumed in chilled and fresh form.

e) Industries are operated by people who lack proper education in fish processing. The basic science of fish handling and the characteristics of fish as human food is not well understood by processors.

Thailand

a) Quality of fresh fish is inconsistent. There is a need to improve handling on board, landing places and transportation of fish.

b) To improve health and safety through quality control, technology adaptation, packaging and product form.

c) Upgrade quality of raw materials and processed products. Promotion of value-added export products.

d) To encourage use of trawl by-catch and underutilized species. To improve product quality to meet health and safety standards for shellfish utilization.

e) To improve technology transfer to the private sector especially the small-scale industries. Lack of fund in training and strengthening technical capabilities of government personnel.

Marine Fisheries Research Department

Results from a survey on fish products among countries in Southeast Asian region indicated the following problems:

a) Raw Materials
   i) shortage of supply,
   ii) poor quality of supply due to poor handling, and
   iii) inconsistency of supply.

b) Final Products
   i) lack of in-plant quality control,
   ii) poor sanitation and hygiene of premises and processing treatments,
   iii) lack of proper facilities/equipment,
   iv) use of outdated processing technology, and
   v) inadequate packaging.

c) Marketing Problems
   i) inconsistent product quality,
   ii) high degree of spoilage, and
   iii) short storage life.

DISCUSSION ON CONSTRAINTS

Discussions on constraints ensued as follows:

Fresh fish handling

Dr Prasert stated that the training of fishermen in fish handling is vital because the quality of fish supplied to processors depends on them. Processors need consistent quality raw material.

Dr Amano observed that, with the price of ice in Southeast Asia relatively cheaper than in Japan (US$8.60/100 kg), more ice should be used by the fishermen to preserve their catch.

Country	Price/100 kg of ice (US$)
Indonesia	2.00 - 4.00
Malaysia	2.40
Singapore	4.00
Philippines	3.00 - 4.00
Thailand	2.00

He inquired about the use of refrigerated sea water (RSW) which was introduced in Canada for the preservation of fish.

Mr Haniff replied that in Canada RSW is used to preserve pelagic fish. For other species, ice is used. Pelagic species do not absorb much water and the quality remains good during the two-day storage.

On the subject of preservation of fish on board, Mr Inoue explained that small fishing boats in Thailand carry enough ice on board and the freshness of the caught fish is good enough for *"sashimi"*. Large trawlers with refrigeration facilities on board also have no difficulty preserving the catch. The problems are with medium-sized trawler which carry only enough ice to preserve their catch for 10 days.

SEAFDEC Training Department has tried to introduce RSW in medium-sized fishing vessel. Because of limited engine room space the refrigeration machines were placed in the bulbous bow to provide RSW. A one-year experiment showed savings of 10% in fuel costs, and better vessel stability; however it was difficult to service the machine in the bulbous bow.

Nevertheless it is still necessary to introduce small and efficient refrigeration units that can fit into medium-sized vessels which are popular in the region.

Dr Matsumoto inquired whether fishermen in Southeast Asia are paid well for good quality fish.

Ms Camu replied that in Philippines, as a general rule better quality fish fetched higher prices.

Mr Megat said that in 1984, Malaysia conducted an experiment on the relationship of price to the quantity of ice used on board boats. They found that in the local/domestic market fishermen got the same price for different quantity of ice used whereas for the export market i.e. Singapore, they were paid 20-30 cents more per kg of fish for better quality when they used extra ice worth between M$10 — M$15 per boat trip.

Dr Prasert said that in Thailand the question of a premium price for better quality is usually resolved by compromise between fishermen and buyers. Some species can fetch a higher price but that varies with season.

Traditional Products

The delegate from Thailand highlighted the problem that although raw materials are available all year round quality and species vary. Another problem is the lack of sanitation in processing and inconsistent product quality. This shows a need to improve sanitation and processing techniques.

It was suggested that studies be conducted to overcome problems of varied quality of fish supply at different times of the year and to develop standard methods for processing of products.

In the Philippines the main problem is the lack of in-plant sanitation.

The Malaysian delegate said that a major constraint is inconsistent supply of good quality raw materials. Processors are usually fishermen or members of fishermens' families who cannot afford to adopt new technology. However, training courses are being provided to these processors to create awareness of better processing methods and equipment available.

MFRD was requested to provide assistance whenever possible.

Commenting on discussions about the standardisation of processing procedures, Dr Amano suggested that the processors themselves should initiate the task by forming cooperatives or associations. In agreeing with Dr Amano, Mr Haniff mentioned that in Canada the private sector had worked with the government to formulate standardised procedures. Dr Prasert commented that the processors themselves may not be able to standardise the processing methods, especially when the products involved are traditional rather then conventional. Hence, there is a need for government guidance.

Dr Matsumoto suggested that consumers should be educated via radio and other mass media on product quality and acceptability so that processors could cater to their requirements.

Fish Products For Export

The delegate from Philippines said that the main constraints have been slow transfer of technology and inability of processors to adopt new technology. Other problems are poor facilities and lack of quality consciousness among processors.

The Indonesian delegate was of the view that the problem of hygiene and sanitation should be tackled by the national government. However he suggested that MFRD undertake studies on development of equipment to ensure more efficient processing — e.g., reducing freezing time. MFRD replied that it reviews and recommends suitable equipment and technology available in the market for use in the region. However, machine manufacturers can be approached to cater to specific requirements.

Training

The Chairman suggested that member countries should organise appropriate training courses for the private sector with the assistance of MFRD.

With regard to training, Mr Hooi said that in SEAFDEC, results of R & D will be disseminated to member countries. Durations of training courses have been reduced to enable greater

participation from member countries. The total annual number of participants have also increased over the years. He also said that in MFRD, training courses are being continually revised, and emphasis has been given to developing training modules. For example, starting in 1988 the training course on biochemistry methods for fish quality assessment will be run on request by member countries. Training manuals are being produced to supplement the training courses. This will enable member countries to conduct their own training courses and thus increase the number of trained personnel.

Resource Papers

Overview of Current Fish Consumption and Fish Processing in Southeast Asia

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Food Fish Supply in the Region

The amount of local fish consumption in 1978 and 1984 was roughly estimated using the data in the SEAFDEC Fisheries Statistical Bulletin for the South China Sea Area, by adding the amount of fish imported to the local fish production and deducting the amount of exported fish in each country and the amount of fish reduced to fish meal and fertilizers. The majority of trash fishes are not directly utilized for human consumption in Thailand, and were therefore excluded from local consumption.

The per capita fish consumption was calculated by dividing the estimated local fish consumption by the total population and is shown in Table 1.

Per Capita Fish Consumption

The regional per capita fish consumption in 1978 and 1984 was 23 kg and 21 kg, respectively.

The reasons for the slight decrease in the figure for 1984 can be explained as follows:

a) Total population in the region increased 15 per cent, and local fish production in the region only increased from 6 million tons in 1978 to 7.1 million tons in 1984.

Table 1. Balance of supply and demand of fish

		Local Production	Import	Export	Reduction	Local Consumption	Population Size	Per Capita Consumption
Brunei	a	3	2	0	—	5	0.2	25
	b	5	2	0	—	7	0.22	32
Indonesia	a	1,648	27	63	—	1,612	136.6	12
	b	2,261	4	52	19	2,194	161.6	14
Malaysia	a	685	157	130	62	650	12.9	50
	b	672	237	138	108	663	15.2	44
Philippines	a	1,580	48	49	—	1,579	46.7	34
	b	2,080	6	63	—	2,023	53.2	38
Singapore	a	16	815	58	—	773	2.3	—
	b	25	151	84	—	92	2.5	37
Thailand	a	2,099	29	235	921	972	45.5	21
	b	2,135	119	412	844	998	50.4	20
Total	a	6,031	1,078	535	983	5,591	244.3	23
	b	7,178	519	749	971	5,977	283.1	21

Source: Fishery Statistical Bulletin for South China Sea Area

Unit: Production — '000 mt
Population — Million
Per Capita Consumption — kg

Year: a = 1978
b = 1984

b) The amount of imported fish declined from 1 million tons in 1978 to 0.5 million tons in 1984, and the amount of exported fish and fishery products increased from 0.5 million tons to 0.7 million tons during this period.

The local fish supply may not be sufficient to meet the requirement for animal protein in the region.

The average price of fish, excluding shrimp and squid, which are exportable products, is higher than the general consumer price index in Thailand.

The average per capita fish consumption varies for each country; for example, in Brunei, it has increased remarkably due to an increase in local production and the amount of fish imported.

In the Philippines, the per capita consumption has increased although the amount of exported fish commodities also increased.

Per capita fish consumption in Thailand has dropped from 21 kg in 1978 to 20 kg in 1984, due mainly to an increase in the quantity exported in spite of a slight increase in local production. When looking at the amount of "reduced" fish in Thailand in Table 1, we can see that more than 40% of the total production was reduced to fish meal and therefore not used for human consumption.

Thailand should introduce appropriate measures to prevent over exploitation of precious fish resources and utilize these resources more carefully. The reduction of fishing effort and introduction of mesh size regulations would ensure proper management of the resources. If 50% of the trash fish could be utilized for human consumption, the per capita fish consumption would be increased, or foreign exchange could be increased by exporting these fish in the form of "surimi".

Disposition of Marine Fish

Table 2 shows the disposition of fish in the region. Of the total fish production in 1984, 38% was consumed in its fresh form, followed by 20% as dried and salted fish. Fish in Asia is traditionally consumed fresh and as dried or salted fish products; as these were the only methods of preservation available for such perishable commodities before the introduction of modern technologies for the preservation of fish products, such as canning and freezing, etc. Since fish is perishable and cannot be kept for long, the cost of fish which cannot be sold fresh, and is thus used for processing, is lower than that of fresh fish and often results in poor quality processed products. That is why the price of processed

Table 2. Disposition of marine fish

		Total	Fresh Fish	Freezing	Canning	Dried & Salted	Steamed/ Boiled	Fermented	Other Curing	For Reduction	Others
Brunei	a	3	3	—	—	—	—	—	—	—	—
	b	—	—	—	—	—	—	—	—	—	—
Indonesia	a	1,227	591	24	6	470	66	60	6	—	4
	b	1,713	854	46	17	606	121	44	16	—	9
Malaysia	a	627	419	15	—	62	—	9	2	62	58
	b	579	328	6	—	84	15	15	10	108	13
Philippines	a	—	—	—	—	—	—	—	—	—	—
	b	—	—	—	—	—	—	—	—	—	—
Singapore	a	16	16	—	—	—	—	—	—	—	—
	b	25	25	—	—	—	—	—	—	—	—
Thailand	a	1,839	470	150	27	193	32	16		899	52
	b	1,912	404	198	173	170	22	100		840	5
Total	a	3,712	1,499	189	33	724	98	85	8	961	114
	b	4,229	1,611	250	190	860	158	159	26	948	27

Source: Fishery Statistical Bulletin for South China Sea Area

Unit: '000 mt

Year: a = 1978
b = 1984

fish is cheaper than fresh fish.

In Table 2, we can see that the disposition of fresh fish in Indonesia and Thailand was roughly 50% and 20%, respectively in 1984, and for dried and salted fish about 35% and 9% respectively.

This can be explained by the fact that Indonesia has maintained a traditional consumption pattern while Thailand, on the other hand, has well developed canning and freezing industries, as shown in Table 3. While canning and freezing are better ways of preservation, although the traditional methods of drying, salting, steaming and fermenting are still popular in the region (see tables 2 and 4). It is therefore necessary to improve the standard of the traditional preservation methods.

When we look at the Japanese experience, the consumer's preference becomes more diversified with improvements in his economic condition. Traditional processed products can be sold at a higher price once their quality is improved by the introduction of advanced technology.

Fish Quality Improvement

When I first went to Thailand 20 years ago, the price of fish at wholesale markets varied according to species, but did not reflect the freshness of the fish. The current Manager of the Fish Marketing Organisation of Thailand told me that nowadays the price of fish varies according to quality.

Fishermen can sell live prawn at a higher price than dead prawn, and fresh fish suitable for *"sashimi"* can be sold at a high price in Bangkok.

Since the available fish resources are almost fully exploited in the region, fishermen cannot expect to raise their income by increasing their catch. It is, therefore, important to encourage fishermen to preserve the freshness of the fish on board to get better prices.

Ice has been used on Thai trawlers, but is not sufficient to preserve freshness over a long period.

Malaysian trawlers installed refrigerators on board to preserve freshness using cold sea water, but the quality of fish is still not high enough. It is therefore important that efficient refrigeration systems be introduced to the region.

Table 3. No. of cold storage and capacity (1979 — 1985)

	No. of Cold Storages	Freezing Capacity ton/D	Storage Capacity M^3	Quantity of Fresh Stored (1000 mt)				
				Total	Fish	Shrimp	Squid	Others
1979	29	618	14,524	110	5	24	40	11
1980	29	705	14,404	124	59	23	59	3
1981	34	954	14,686	109	41	26	40	2
1982	41	1,112	16,821	123	70	16	35	2
1983	47	1,316	22,240	120	59	18	41	2
1984	54	1,470	25,590	200	94	28	70	8
1985	56	1,517	29,940	247	127	36	77	7

Source: Department of Fisheries, Thailand
Quantity = '000 mt

Table 4. No. of fish processing factories and fish materials used (1981-1985)

	Fish Sauce		Shrimp Paste		Fish Dried & Salted		Dry Shrimp		Dry Squid		Fish Ball		Others	
	No.	Q	No.	Q	No.	Q	No.	Q	No.	Q.	No.	Q	No.	Q.
1981	103	90	533	17	393	95	161	25	351	27	10	0.3	177	30
1982	96	30	2,377	7	676	34	301	20	826	31	52	0.3	1,621	27
1983	110	28	2,603	13	759	39	276	27	854	39	52	3.2	1,898	24
1984	113	24	2,860	15	800	59	284	42	865	47	64	3.5	1,213	23
1985	114	19	2,725	12	978	62	148	40	879	47	64	2.9	1,069	19

Source: Department of Fisheries, Thailand
Q = '000 mt

Utilization and Post-Harvest Technology of Sardine, in Relation to Nutrition and Health

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Summary

Fish consumption in Japan is very high compared with other countries. Consumption runs at approximately 96 grams daily per capita, providing a good balance of protein, fats and oils, and carbohydrates.

The total fish catch in 1985 was 12,170,000 tonnes. The largest component was sardine which, at 4,200,000 tonnes, accounted for 34.5% of the total.

Attempts are being made to go beyond traditional sardine products to new forms such as surimi. In fatty sardine fish (with lipids ranging about 10-20%), the characteristic components are generous amounts of poly-unsaturated fatty acids (PUFA), which lower blood cholesterol level. One of the PUFA, eicosapentaenoic acid (EPA) has the effect of lowering incidence of adult diseases such as myocardial infarction. Gelatin capsule including tocopherol is useful for the prevention of fish oil oxidation.

Tests of traditional dried sardine products showed that lipid oxidation and hydrolysis had already occurred.

General Introduction to Marine Processed Products in Japan

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Summary

World's and Japan's Catch

The total world catch exceeded 80 million tonnes in 1984. The major fishing nations were Japan, USSR, China, USA and Chile.

Japan's catch was over 12 million tonnes. Sardine catches were high. There was a decline in catches of alaska pollack.

Some other observations on the fishery scence for 1984 are summarised below.

Imports and Exports (World and Japan)

Total world fish imports were over US$18 billion. Major importers were Japan and the USA.

Total world fish export was US$16 billion. Canada, USA, Denmark, Norway and Japan were leading exporters.

Japan's total imports was US$5 billion, mainly from USA, South Korea, Taiwan, India and Indonesia.

Japan's total exports was about US$0.8 billion. Taiwan, Holland, USA and West Germany were the major markets.

Factors Influencing Changes in the Japanese Market for Fish and Fish Products

Japan's processing capacity was about 8.8 million tonnes. Frozen product 4.3, oil and meal 1.7, fish jelly products 0.99, salted and dried products 0.9, canned product 0.32, frozen food 0.25 and others were 0.35 million tonnes.

Establishment of 200 mile EEZ's, adoption of allocation systems and the imposition of fishing fees forced Japan to utilise new variety of raw materials. Changes in consumer needs and types of raw materials available and appreciation of yen also forced Japan's manufacturers to change their management attitude.

Cryoprotective Effects of Chemicals on Proteins of Fish Muscle

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Introduction

Since freezing appeared at the beginning of this century as a new technique of storing fish, very many works have been published with regard to the technical improvement of freezing in order to improve the quality of frozen fish. Studies were also carried out to clarify the cause of deterioration of meat during frozen storage.[1,2]

Results of studies on the factors affecting the quality of frozen fish may be summarized as follows:-

1. Species of fish,
2. Prefreeze freshness of fish meat,
3. Freezing speed,
4. Condition of frozen storage:
   - Temperature
     — Depth
   - Stability (including repeat of freezing)
   - Contact with air
     — Glazing,
     — Package,
5. Thawing speed, and
6. Cooking method.

In contemporary fisheries the practice of freezing seems to satisfy much of these factors, so that frozen fish is sold in fairly good quality. However, there is still left a definite gap in meat quality between the fresh fish and the frozen fish. Particularly in some fish like the Gadoidae, the deteriorative effect of freezing is serious, and specially so in the decrease of the functional properties for processing the meat. Namely, the fish meat becomes hardly processable into fish gels like *kamaboko* and fish balls. Such damage was attributed mainly to the denaturation of proteins caused by freezing and storage.

The above gap was overcome by a novel technique called *"reito surimi"* (frozen mince) or rather popularly "surimi". The technique was proposed in 1959 by a group of fish technologists in the Prefectural Government of Hokkaido, Northern Japan. The group was headed by K. Nishiya.[3] This technique was able to significantly reduced the denaturation of protein and the processed meat could be used for producing *kamaboko* even after frozen storage for more than a few years. It must be pointed out that this technique was used successfully to freeze meat of gadoid fish which have been regarded the most susceptible to freezing denaturation. This finding has resulted in the full use of the previously underutilised resources of Alaska pollack in Northern Pacific.

As is well known now, surimi processing consists of two elements; one, removal of water soluble matters by washing, and the other, protection of proteins against freeze denaturation by addition of cryoprotectants.[4] During washing, inorganic ions, low molecular organic matters and water-soluble proteins are removed. The cryoprotectants employed in the original surimi of Nishiya are sucrose (5-10%), sorbitol (0-5%) and polyphosphates (0.3%).

Search for Other Cryoprotectants

In our laboratory, we have carried out a series of experiments to search for other potential cryoprotectants, resulting in the finding of several effective ones other than those used in the original prescriptions.[2,5-14] In the present paper our contributions will be briefly reviewed; suggestions for further studies on fish freezing and surimi production and production of novel processed foods will also be discussed.

Our experiments were mainly based on *in vitro* freezing tests of isolated fish proteins.[5] The cryoprotectants were added to the protein solution prior to freezing. After frozen storage for a definite period the content of the test tube is thawed and submitted to analyses and measurements of various items. This

experimental approach allowed us to acquire quicker answers with higher precision.

After screening more than 150 kinds of compounds we found several substances which demonstrated very good cryoprotective effects. Representative cryoprotective compounds found effective on fish actomyosin are:

Amino acids	with marked effect	Na-glutamate, Na-aspartate, lysine-HCl, cysteine, cysteate
	with moderate or little effect	alanine, serine, threonine, β-alanine, γ-butyrate
Dicarboxylic acids	with marked effect	malonate, glutarate
	with moderate or little effect	adipate, pimelate, maleate
Hydroxy carboxylic acids	with marked effect	glycolate, glycerate, lactate, gluconate, malate, tartrate, citrate
Polyalcohols	with marked effect	ethylene glycol, propylene glycol, glycerol, sorbitol
	with moderate or little effect	1,4 butanediol
Sugars	with marked effect	arabinose, glucose, mannose, galactose, fructose, sucrose, lactose, melizitose, stachiose

Each compound was added in a neutral form, viz acidic or basic ones were neutralized before use. Among the compounds listed above some of them like glucose, galactose, fructose, lactose and sucrose had been already reported by Nishiya's group.

With those compounds found very effective, application tests for *kamaboko* processing were also conducted, turning out similarly successful results.

Behaviour of Carp Actomyosin During Frozen Storage

Now, how the cryoprotective effects were proved will be described. For the additive cryoprotectant, sodium glutamate was most frequently used because it was outstandingly effective among the compounds found effective.

Carp actomyosin was freeze stored either in the presence or absence of 0.1-0.3 M sodium glutamate. Without sodium glutamate, actomyosin showed that it was denatured in every aspect tested, namely solubility, viscosity, ATPase activity, sedimentation profiles, etc. In the election microscopic profiles of the freeze denatured actomyosin the fine structures of the native actomyosin were lost and the filaments became aggregated with each other. When sodium glutamate was added prior to freezing those changes were definitely prevented.[5-18]

As far as there is aggregation of protein molecules taking place, there must be some kind of intermolecular bonding having been formed during frozen storage. This was proved by a differential redissolving experiment on actomyosin and myosin. The bonding was attributed to hydrogen bonds, ionic bonds, S-S bonds and nonpolar bonds.[19]

Behaviour of Myosin, Actin and Other Constituent Proteins During Frozen Storage

Similar experiments were conducted on each constituent protein of fish muscle, namely myosin, myosin subunits, actin, tropomyosin and lactate dehydrogenase. The last was studied as a representative of water soluble proteins, the so called myogens.

Decrease of solubility and viscosity during frozen storage was found in myosin and actin. Fall of biochemical properties such as ATPase activity of myosin, G-F transforming capacity of actin and enzymic activity of lactate dehydrogenase, was proved to occur in frozen storage. However, these changes, due to frozen storage, were depressed markedly when sodium glutamate was added to the system before freezing.[4,20,21]

Similar experiments were conducted on

subunits of myosin, namely H-meromyosin (HMM), L-meromyosin (LMM), S-1 and rod fragments, confirming denaturation taking place in each subunit, as well as its prevention by added sodium glutamate. It was to be noticed that the freeze denaturation occurred not only in the α-helical structure (tropomyosin, LMM and rod fraqment) but also in the nonhelical, random structures (actin, lactate dehydrogenase, HMM and S-1 fragment).

These results suggested that there was not only inter-molecular aggregation of whole protein molecules but also transconformation of each molecule, namely change of intramolecular structures.

To confirm these, experiments were conducted to study the changes in the intramolecular confirmation by use of differntial spectrometry, and measurements of natural fluorescence, probe fluorescence by naphtalene sulfonic acid (ANS) and circular dichrosism. Thus, it was confirmed that the transconformation occurs both in α-helical structure and in randomly coiled structure. This finding was to rewrite the conventional model of freeze denaturation of fish proteins[2] where the intermolecular aggregation of protein molecules not accompanying any transconformation is the major and sole change which occurs in the case of freeze denaturation.[14,21] It was remarkable that these conformational changes were also definitely or considerably depressed under the presence of sodium glutamate.

Mechanism of Freeze Denaturation and of Effects of Cryoprotectants

Based on the whole results of the screening tests for the cryoprotective effects of various compounds, all the tested compounds were lined up according to mutual similarity of the molecular structure.

Such study led us to assume the following regarding the structure of a cryoprotective compound.[2,5,13,14*]

1. The molecule must bear one essential functional group as well as more than one supplementary functional group as listed below:

- Essential functional groups

  Organic compounds — COOH or — OH

  Polyphosphates — PO_3H_2

- Supplementary functional groups — COOH, — NH_2, — SO_3H, OH and/or — SH

  Polyphosphates — PO_3H_2

2. Suitable distance and suitable configuration between the functional groups on a molecule.

3. Moderate molecular size.

When the cryoprotectant molecules are brought to the neighbourhood of a protein molecule, the protectant molecules are associated with the protein molecule via bonding between the functional groups, one on the protein, and the other on the cryoprotectant. The bonds are either of hydrogen bonds, ionic bonds, or S-S bonds. It results in a state where the protein molecule is coated with the cryoprotectant molecules. Because each cryoprotectant has more than two functional groups and since it keeps more than one functional groups free, these free groups must work either to hinder association of the protein molecules by electrostatic repulsion (the case with ionic groups) or to hydrate themselves as to bring about increased hydration of the protein as a whole (case with ionic groups and other hydrophilic groups like — OH). These must result in reduced associative force between the protein molecules.

In the case of the globular proteins, the increased hydration should resist against the removal of water on the occasion of freezing and must retain some portion of water in the neighbourhood of protein molecule. This must prevent the rupture of the intramolecular nonpolar bonds which are contributing to stabilization of the folded (randomly coiled) structure of the globular proteins.

The cryoprotective effect of the polyhydroxylic compounds such as mono- and oligosaccharides and polyalcohols, is interpreted as working on a principle distinct from above. Namely, these componds must function by interfering with the freezing-out of the ice crystals from the system. This view has its experimental bases in the facts, one, that the amount of freezing water is much less in a sugar-added meat system than a non-sugar system,[23] and the other, that the election microscopic profiles of carp actomyosin are very different between the glucose added system and the glutamate added system,[14,15]

* Mainly based on Noguchi's proposal[13] with partial amendments.

though the freeze denaturation is well depressed in both the cases.

The details of the facts and the reasonings will be published elsewhere.

Conclusion

Although the current surimi industry mainly relies on the principle of the original technique and its prescriptions of the additive cryoprotectants, namely sucrose, sorbitol and phosphates, there are good ground for developing other cryoprotectants to replace the popular ones. Introduction of a new cryoprotectant might enable us to broaden the variety of material fish, to bring about gel products of novel types of flavour, taste and texture, and to create new kinds of foods attractive for local consumers. This might stimulate the birth of an even more prosperous food industry related with surimi.

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Discussion of Resource Papers

DISCUSSION OF RESOURCE PAPERS

"Overview of Current Fish Consumption and Fish Processing in Southeast Asia"

Noting the evident decrease in per capita fish consumption in some countries as outlined in the presentation, Dr Matsumoto asked whether fish had in fact been replaced by other foods. Mr Inoue replied that it was possible that poultry had been the major replacement. Dr Prasert said that the price of fish had increased relative to poultry.

Dr Matsumoto asked if Mr Inoue could elaborate on the increase in per capita purchasing capacity, if any. Mr Inoue said it had increased — particularly in urban areas. The rural areas were still lagging behind.

Mrs Pongpen doubted that fish consumption had declined in Thailand. She believed that in fact it may have increased and that more data was required before a conclusion could be made. Mr Inoue said that while some of the data was possibly open to correction, this was a matter of the accuracy of existing statistics.

"Utilization and Post-Harvest Technology of Sardines in Relation to Nutrition and Health"

Dr Sunarya asked whether the Eicosapentaenoic Acid (EPA) content of tropical fish is higher than that of species in temperate zones. Dr Wada said that some tropical fish contains more EPA.

Dr Prasert asked about the difference in EPA content between marine fish and freshwater species and between fish living in different temperatures. Dr Wada said most marine fish appear to have a higher EPA content. This may be due to differences in metabolism. Fish diet of sea plants may also affect the EPA content.

Dr Prasert asked about the difference between EPA and Decosahexaenoic Acid (DHA). Dr Wada said the difference essentially is in the number of carbon atoms, DHA having two more carbon atoms than EPA and one more double bond.

Mrs Pongpen asked whether other activities of fish would affect phospholipid contents. For instance would cholesterol levels vary between bottom-dwelling and pelagic species? Dr Wada replied that polyunsaturated fatty acids in phospholipids are present in higher levels in bottom-dwelling fish than in pelagic species, regardless of fat content.

On the subject of surimi products, Mrs Pongpen asked whether the colour of the surimi from red meat fish could be improved. Dr Matsumoto said surimi from red-meat fish is produced in western parts of Japan and that technology existed to separate dark from white meat. The equipment is however, not ready for commercial purposes. He said production of surimi using sardines is taking place in some areas. The meat is more thoroughly washed. Dark and white meat can be separate by differential flotation. Dr Amano added that demand was not established for surimi from red meat fish.

"General Introduction to Marine Processed Products in Japan"

In response to a question by Mr Boey about changes in Japanese fish consumption patterns, Mr Shindo said that one factor was a growing tendency among younger people to favour meat over fish and this trend was reflected in changes in consumption of both products.

A secondary reason for the change was said to be a dislike by younger people of the strong odour of fish.

Mr Shindo said that the Japanese Government was concerned about the decline in fish consumption and was trying to reverse the trend by stimulating the introduction of new products and new marketing ideas.

Mr Haniff asked whether fish jelly products could perhaps stimulate increased fish consumption in Japan. Mr Shindo replied that in general fish jelly product consumption is on the decline in Japan while consumption of traditional (natural) foods seems likely to increase.

Dr Sunarya noted the conflict between the need to increase the amount of fish available for human consumption and the need to increase fish meal for aquaculture. Mr Shindo replied that the objective should be to provide enough fish for human consumption and then to strike a reasonable balance between the two goals.

"Cryoprotective effects of chemicals on proteins of fish muscle"

Dr Ng noted that the maximum storage time for actomyosin reported in the paper was six weeks and asked whether this was in fact the maximum keeping time under all circumstances. Dr Matsumoto replied that the six-week period showed in the experiment was not planned to specify the maximum. In fact the results at nine weeks were the same.

Dr Sunarya asked if there was any relationship between salt soluble protein and the quality of surimi — in particular the gel strength. Dr Matsumoto replied that there is a relationship but observed that the species of fish is another factor influencing this quality.

Case Histories

A Case History of Fish Jelly Product Development in Sarawak, Malaysia

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Introduction

Fish is an important source of protein of the food consumed in this country since it can be obtained readily and cheaply. Beside being consumed fresh, considerable quantities of fish are processed before being consumed. There are various methods of processing, which have been practised widely throughout the state, nevertheless these methods of processing are traditional in nature. The most common traditional methods of processing are by sundrying, smoking and fermentation (fish sauce, shrimp sauce and shrimp paste). Despite the inferior quality of these products, the overall demand has been very consistent, infact some of the products are prepared as traditional dish.

An important event was recorded in the history of fish processing in the state of Sarawak when fish jelly processing technique was first introduced in 1984. This new technique of processing ensured a better future for fish processing in this state, since it has flexibility in its application. It is hoped that with this new technology, the percentage of wastage of fish which is considerable, could be lowered since the "trash fish" could be utilised in the processing.

Technology Developments

Traditional fish processing methods normally do not employ complicated devices and equipment in their operation. Since these methods are still widely practised in the state, therefore generally there has been little improvement in technology in this area especially at the fishing village level. Nevertheless in the major towns in the state, fish processors have shown interest in using new technology in fish-jelly processing. This is supported by the fact that since 1984 some seven new processing factories have been set up in the state using this new technology with the aid of new equipment such as meat-bone separators, strainers, mincers, mixers, fish ball forming machine, slicers and others.

Some Socio-Economics Factors Affecting the Development of the Fish Processing Industry

Socio-economic factors play an important role in the development of the fish processing industry especially in relation to fish jelly processing in the state. Some of the factors which affect the development of the technology of fish processing are:

Attitudes

Generally when a new product, such as fish jelly, is introduced to a community, it does not find acceptance at first sight, especially so where the community in question has been familiar with the traditionally processed product. Efforts to popularise fish jelly products in the fishing communities have been made for the last three years. Considerable interest has been noted on the part of the fishing community towards fish jelly products as a whole.

Preference

Generally a community has its own preference in terms of the type of food it takes. This is influenced by the environment, beliefs and traditions. Because fish jelly products are less preferred by the local communities the market for the market for them is limited.

Standard of Living

Normally the supply of fish jelly products is limited and thus the price of the commodity is slightly higher than the traditionally processed fish products. The pricing factor therefore affects the choice of the consumer on the whole, since the general standard of living is fairly low especially in the rural areas.

Geographical Factors

In the state of Sarawak, fishing centres and villages, which are potential areas for development of fish processing, are scattered along the coastal areas where communication is a problem. Inadequate public amenities such as electricity and water supply also pose a

hindrance to the setting up of even small-scale processing factories in these centres.

For these reasons the progress in development of fish processing in the rural areas of Sarawak, particularly in the fishing centres, has been slow. The processors in these areas have had to be content with the traditional methods that they have been using since the old days.

Mechanism for Transfer of Technology

It has been the intention of the government to raise the income of the rural populace, including the fishing community which is considered to be within the poverty circle. Various programmes are being carried out by government agencies such as the Fisheries Department and others to elevate the standard of living of the rural communities. In the fisheries sector, new technologies have been identified that could be used to enhance effective fishing efforts and to improve post harvest practices thus improving the income and standard of living of fishing communities.

The Fisheries Department through its extension programmes has established the "training and visit" system throughout the state. In this system, extension agents are posted in each Fishing District to implement various extension programmes including transfer of technology to the target group.

Another effort to execute the transfer of technology to the target groups is carried out through training courses conducted at our Extension Centres as well as at fishing village level. Training courses have been conducted among the fishing communities since 1984. To date, the department has trained 711 persons in fish jelly products processing (Table 1).

Table 1.
Number of course participants attending fish jelly products processing training course in Sarawak

Year	No. of participants
1984	86
1985	198
1986	233
1987	194 (up to Oct. 1987)
Total	711

Up to now, the Fisheries Department has established two Extension Centres in Sarawak, located in Kuching and Belawai while two are being constructed in Mukah and one is planned for Miri. These extension centres are equipped with wet and chemical laboratories. The facilities available in connection with fish jelly processing at the two Extension Centres are as follows:-

1. **Kuching**
   a) Manpower — 2 officers
      — 2 technicians
   b) Chemical laboratory with sufficient basic chemicals and equipment
   c) Wet laboratory — equipped with the following machineries:-
      (i) meat-bone separator
      (ii) strainer
      (iii) mincer
      (iv) mixer
      (v) fishball forming machine
      (vi) slicer
      (vii) freezer
      (viii) refrigerator

2. **Belawai**
   a) Manpower — 2 technicans
   b) Chemical laboratory
   c) Wet laboratory — equipped with the following machines:
      (i) meat-bone separator
      (ii) mixer
      (iii) mincer
      (iv) fish ball forming machine
      (v) freezers
      (vi) refrigerators
      (vii) slicer machine

Conclusion

Fish jelly processing could be developed into a viable scheme both at the fishing village level (cottage industry) and on commercial scale. This could be achieved if transfer of technology to the target group can be implemented smoothly. It is therefore recommended that extension officers be given sufficient training in this subject so that they could be competent to extend the knowledge to the target group.

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Utilization of Trawl By-catch for the Development of Surimi and Surimi-based Products (1979—1987)

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Introduction

Recognising the need to improve the post-harvest technology of the fishing industry in the Southeast Asian region, the 8th Council Meeting of SEAFDEC in 1975 recommended that the Marine Fisheries Research Department (MFRD) in Singapore undertakes a programme on fisheries post-harvest technology. The Japanese Government was requested to send a survey team headed by Dr K Amano to the member countries to identify the status and problems of the fishing industry in the region, with specific emphasis on post-harvest activities. One of the recommendations of the two study tours conducted by the team was the need for more efficient utilisation of the trawl by-catch for human consumption. The MFRD then set up facilities and activities for work in fishery post-harvest technology and initiated a project on trawl by-catch utilisation, initially to assess the suitability of the resources as raw materials for making popular traditional products.

Research and Development

With the increase in landings of small demersal fish (by-catch) in the region, the problem of using this low market value fish resource for human consumption was of immediate concern for MFRD. A project was initiated in 1979 to investigate the use of this resource as a raw material for the production of comminuted products, which included the production of frozen surimi, and the development of a range of fish jelly products.

Production of frozen surimi

The research carried out included developing a processing method based on the adaptation of existing technology and identifying suitable equipment for small-scale and large-scale production (Tan *et al* 1981). The research also included the introduction of several basic technological concepts.

a) Leaching of the fish mince. This is a most important step in the production of surimi; washing eliminates the components that interfere with gel-formation and makes it possible to utilise not only a wider range of fish species but also raw materials that are not so fresh. Cheap and abundant fish species can now be processed into fresh or frozen mince for the production of good quality fish-jelly products.

b) Use of sugar as a cryoprotective agent. Experiments were conducted to determine the shelf-life of surimi made from by-catch with varying amounts of sugar. The results indicate that the use of 5% cane sugar was enough to maintain a shelf-life of 6 months at -20°C. This was also suitable in terms of reduced sweet taste as compared with Japanese surimi.

c) Gel-forming ability studies of the various species of the by-catch (Poon *et al* 1981). This led to better sorting of the by-catch.

d) Methods to assess the quality of surimi and fish jelly products. This included the use of a Fudoh penetrometer and development of sensory organoleptic assessment techniques.

Fish jelly products

The fish jelly product industry in the region is traditional and is based on the production of fish ball and fish cakes for the noodle and other "fast-food" stalls. The MFRD promoted the concept of producing a wider range of products using frozen surimi. This included the following studies:-

a) Production of a wide range of fish jelly products both manually and with machines.

b) Setting the product at higher temperature (40°C/20-30 min) to reduce production time

c) Introducing machinery for a wide range of products eg *chikuwa* forming machine, mini-fish cake forming machines, fish roll forming machines etc.

Transfer of technology

By 1980, the MFRD began to transfer the technology developed to the fish processing industry. This involved conducting training and demonstration courses designed to popularise and transfer the technology developed. The transfer of technology was directed towards 3 categories of personnel.

a) Fish processors in Southeast Asia, interested in the production of surimi and mince meat. This involved conducting training and demonstration courses on the processing methods, including visits to their factories to assist in production trials, consultation and advice on machinery and processing techniques, assessment of their products etc.

b) Fish jelly product manufacturers interested in the use of surimi for the production of fish jelly products. Processing trials were conducted with the manufacturers in MFRD, to help screen processes and equipment. However, training and consultation also included demonstration on production of surimi, use of surimi for manufacture of a wide range of products, processing control and equipment.

c) Fisheries extension and research officers. The training courses were of a more technical nature which included principles and practices of surimi production and fish jelly product manufacture.

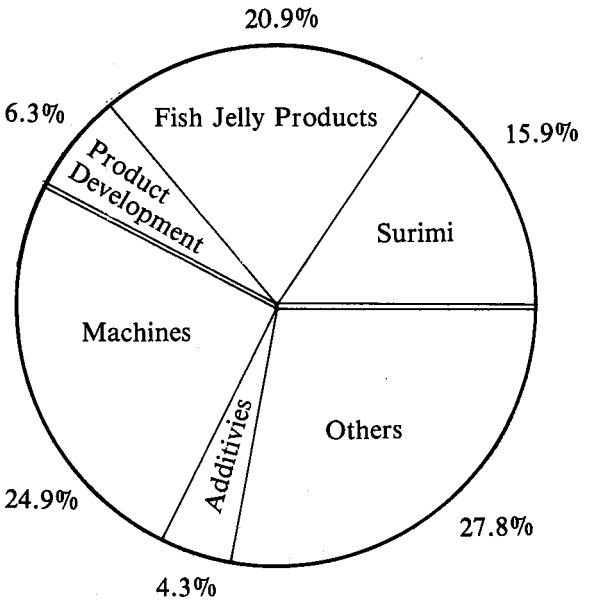
Table 1 gives a list of the training courses conducted and the number of participants from 1980-1987.

In addition to training and demonstration courses, the MFRD maintains close relationship with fish processors through extension activities. This has provided opportunities to monitor changes in the industry. Processors are aware of the well-equipped facilities and responsiveness of the staff and many have visited and used the facilities at their own expense in addition to those who are sponsored by sponsored by SEAFDEC.

Figure 1 shows the extension activities carried out by staff of MFRD from 1980 to 1986. Inquiries raised during visits to factories and by processors visiting the MFRD include questions on surimi, fish jelly products, product development, machinery etc. These inquiries were from processors mainly from Malaysia, Singapore, Thailand and Indonesia, who are keen to produce better and more varieties of quality products, as well as to upgrade their production technology, methods and techniques.

Fig. 1

Extension Activities of SEAFEDC/MFRD (1980—1986)



Results

Since MFRD introduced the use of surimi in th region there has been increasing interest in the industry on both the production and use of surimi in the region.

The number of surimi factories in Thailand is on the increase, at present there being nine factories producing surimi mainly for export to Japan but also to Singapore. Most of the surimi manufacturers have participated in the MFRD's activities.

In 1980, Singapore imported only about 0.5 tonnes of surimi, used mainly by the restaurants. This increased to more than 1500 tonnes in 1986 and there are now many factories producing fish balls and fish cakes us-

Table 1. Training courses conducted by MFRD and no. of participants (1980 — 1987)

	Training Course	No. of courses	Country							
			Malaysia	Philippines	Thailand	Singapore	Brunei	Indonesia	Others	Total
1)	Short-Term Training Course in Post-Harvest Technology	13	20	18	23	14	2	17	(3)*	94 (3)
2)	Regional Lecture/ Demonstration Course for Fish Processors and Technologists	7	26 (8)	33	37 (6)	(5)	0	11 (1)	(2)**	107 (22)
3)	Lecture-cum-Demonstration Course for Local Fish Processors	4	NIL	NIL	NIL	113	NIL	NIL	NIL	113
4)	Short-Term Training Course for Fisheries Technicians	2	6	0	0	0	0	0	0	6
5)	Special Fellowship in Fishery Post-Harvest Technology	2	0	0	2	0	0	0	0	2
6)	*Ad Hoc* Training Course for Fish Processors	2	4	0	5	0	0	0	0	9
	Total	30	56 (8)	51	67 (6)	127 (5)	2	28 (1)	(5)	331 (25)

*1 Sri Lankan and 2 New Zealanders
**1 from AQD/SEAFDEC and 1 from FAO (Bangkok)
( ) = observers

ing surimi. There are also about 4-5 importers of frozen surimi, mainly from Thailand.

Whilst it may not be economically viable for Singapore manufacturers to produce surimi, most of the fish jelly product manufacturers have now incorporated the leaching step into their manufacturing process. This has not only resulted in better quality products, in terms of gel-strength and appearance but also enabled them to use a large number of species including those which previously gave products of unacceptable quality.

Due to its instability, fresh minced meat could not be distributed over long distance and are often of poor quality by the time it reaches the end-users (fish ball-fish cake manufacturers in Singapore). With the incorporation of the leaching process, fish suppliers in Southern Malaysia and Thailand now produce chilled leached meat and maintain its quality for a longer period (2-3 days). This has resulted in better utilisation of the cheap and abundant fish species in the region.

In the late 70s and early 80s the local fish jelly product industry was being resettled as part of Singapore's development programme. MFRD quickened the pace through the introduction of new technology (use of surimi, leaching process, double-step heating at 40-45°C etc). Of particular interest to the manufacturers was the identification and introduction of suitable equipment to mechanise certain aspects of the production of fish balls and fish cakes when the cost of labour was rising rapidly. The MFRD has now establish good rapport with the manufacturers who now come regularly to the Department for advice and consultation.

In addition MFRD has also prepared a handbook, "The Processing of Frozen Surimi and Fish Jelly Products in Southeast Asia" for processors in the region. This handbook will serve as a reference guide and will further assist the industry's development.

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Development of Minced Fish Industry in Thailand

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Introduction

Minced fish can be obtained from various species and offers opportunities for utilization of fish in products of various shapes and sizes. However, the characteristics of a product determine which type of raw material is used. For Asia, products of good elasticity are preferred; therefore, fish of good gel forming ability are chosen as raw material. In Thailand, when no technology has been developed, fish of good characteristic has been used, mixed with salt and seasoning such as chilli paste or vegetable. In recent years raw materials used have changed due to shortages of raw material, elevated prices of certain species and demand for other products of higher value. Moreover, as technology developed, new opportunities for utilizing low valued marine fish were opened. Common species which can be used for minced fish products are:

Spotted featherback *(Notopterus chitala)*
Barred spanish mackeral *(Chirocentrus nudas)*
Spotted spanish mackerel *(Scomberomorus guttatus)*
Black barracuda *(Cyanoglossus macrolepidotus)*
Ocean barracuda *(Sphyraena picuda)*
Yellow barracuda *(Syhyraena optusata)*
Tongue sole *(Cyanoglossus macrolepidotus)*
Large head ribbon fish *(Trichiurus haumera)*
Japanese threadfin *(Nemipterus japonicus)*
Sixth tooth threadfin *(Nemipterus hexodon)*
Spotted finned bigeye *(Priacanthus tayenus)*
Spiny bigeye *(Pseudopriacanthus niphodia)*
Rough flathead *(Grammoplites scaher)*
Spotted flathead *(Thysamophrys crocodilus)*
Blackspotted trevally *(Caranc leptolepis)*
Lizard fish *(Suarida* sp.*)*

Presently, spanish mackerel, barracuda and spotted featherback are used only in restaurants and noodle shops. Fishball factories, mostly use bigeye, ribbon fish and sole. Other low value species such as flathead, and trevally would be their second option. Surimi factories would utilize the available threadfin bream and conger eel while bigeye and croaker would be their second option. Lizard fish is commonly utilized by fish *satay* plants.

The total production of these species between 1974 and 1984 is shown in Table 1. Note that while production of each species is relatively stable, their value is increasing. The price rise of raw materials has been due to an increase in demand. In some cases, this is for producing traditional products such as dried/salted, smoked and fermented products for local consumption. There is also an increase in export. In the fishball industry, the number of factories and their production capacity have increased. This industry once relied heavily on spanish mackerel but as its price rose, competition from the high value salted fish industry drew it away. There was therefore an urgent need for technology development; surimi factories have also substantially increased in number and production since 1981. The number of fishball and surimi factories from 1981 to 1987 is shown in Table 2.

Technology Development

Development in minced fish technology in Thailand has involved improvement of machinery to replace man power, development of new processing techniques and improved utilization of underutilized species as follows:

Mechanical fish deboner

This machine is used to prepare the mince in medium to large scale processing factories. At present two types are in use:

1. A stamping type, developed and produced in Thailand: High input-output capacity can be obtained but the flesh characteristic is inferior to the roller type deboner.
2. A Japanese roller type deboner and a Taiwanese deboner: These machines offer

better yield and flesh appearance, since the contact area between fish and the seperation device is greater. Pressure can also be adjusted. However the price is higher — this applies particularly to the Japanese deboner.

The heading and gutting machine — this machinery is not popular in minced fish processing factories because the cost of manual labour for this operation is low: from 0.40 bahts to 0.50 bahts per kg. Filleted fish are however, still demanded by fishball factories because the cost of filleting varies only from 1.25-2.00 bahts depending on species.

Table 1. Quantity and value of selected marine species 1974-1984

Species		1974	1976	1978	1980	1982	1984
Threadfin bream	Q.	18,975	16,904	23,678	18,016	17,340	15,052
	V.	79,696	71,842	124,547	111,339	117,867	90,227
Monocle bream	Q.	4,630	3,555	191	635	5,877	1,292
	V.	10,186	10,132	818	4,204	79,561	6,626
Conger eel	Q.	1,822	2,306	3,472	2,651	2,141	1,559
	V.	6,194	10,147	18,749	17,921	19,890	10,127
Croaker	Q.	17,933	9,786	15,241	11,206	10,977	11,534
	V.	44,835	46,944	100,896	61,835	64,928	79,352
Bigeye	Q.	12,454	11,673	13,861	16,429	9,630	10,000
	V.	23,633	33,852	73,324	79,024	62,878	43,699
Lizard fish	Q.	12,160	10,644	12,592	10,273	8,614	9,723
	V.	26,753	28,208	47,220	52,803	40,916	35,597
Ribbon fish	Q.	5,542	6,316	8,353	5,987	5,150	3,660
	V.	16,071	19,895	39,677	31,072	27,333	21,348
Wolf herring	Q.	1,454	1,523	3,470	3,574	2,844	2,598
	V.	9,305	11,497	32,756	29,092	29,364	30,159
Mackerel	Q.	4,857	8,849	9,376	11,354	10,252	10,364
	V.	58,771	120,778	141,203	195,630	247,664	288,642
Barracuda	Q.	3,757	3,166	5,044	5,103	5,626	5,261
	V.	20,666	19,469	41,513	45,774	51,936	47,012
Flatfish	Q.	4,092	6,053	7,896	5,969	6,830	5,782
	V.	8,593	22,396	41,549	31,217	41,728	34,927
Scad	Q.	34,792	83,760	107,376	30,964	35,838	44,256
	V.	66,105	137,038	403,734	121,998	169,146	175,455
Trevallies	Q.	10,602	22,284	35,587	23,431	12,851	20,323
	V.	34,986	103,621	224,554	203,147	104,525	178,633
Sardinellas	Q.	58,222	105,622	145,278	105,413	116,898	117,323
	V.	58,222	213,333	408,419	314,131	418,810	352,939
Other food	Q.	82,041	81,895	98,897	84,381	84,505	95,291
	V.	336,368	317,061	517,864	478,878	436,423	535,220
Trash fish	Q.	690,270	620,646	847,421	786,858	812,789	757,637
	V.	690,270	682,711	1,271,132	1,447,818	1,529,226	1,555,038

Source: The Marine Fisheries Statistics, 1974-1984, Department of Fisheries

Q — quantity in mt

V — value in '000 bahts.

Table 2. Number of fishball and surimi factories, 1981-1987

	1981	1983	1985	1987
Fishball factory[1)]	no record	117	139	—
Demand for raw material (ton/day)	—	37.87	36.5	—
Surimi factory[2)]	3	4	6	11
Demand for raw material				
— full capacity (ton/day)	100	125	225	400
— run 50% capacity[3)]	50	62	112	200

Source: Department of Fisheries (1981-1986)
1) Department of Fisheries statistics and estimaed figure for Bangkok area by SRG (1978)
2) Survey data
3) At peak season (Sept-Dec), a big factory can take in as much as 80 tons/day of raw material.

Processing techniques

Fishball, the popular minced fish product, is produced by the same general process — of mixing minced fish with salt and ingredients, setting in warm water and cooking in boiling water. A mixture of fish fillet of various species of fish are normally used. Ingredients are salt (approximately 4%) monosodium glutamate (1%) pepper (1-3%) ice and vegetable. An unknown amount of $NaCO_3$ is sometime added. Starch is added at various percentages from 5-20% depending on the quality of the end product. Processing is heavily dependent on experience, and mostly under no form of weight control since fish used are the common species with known good gelforming characteristics. Processing techniques have not been developed but instruments have gradually replaced man power in the mixing stage and in product-forming. A fishball forming machines was developed in Thailand, and has been the only technical improvement for traditional fishball processing.

In 1980, the Fish Processing Subdivision of the Fishery Technological Development Division with the support of IDRC-(Canada) explored the possibility of using sorted by-catch as raw material for fishball. A leaching method modified from surimi production was also introduced to improve gel forming ability of the raw material. Food additives such as polyphosphate of various types were tried. A new processing method (MFRD, 1980) was studied and recommended to the private industry. This method involves washing minced meat with diluted salt solution, controlled mixing time, sequential addition of ingredients and double-step heating. The new method has been shown to improve the quality of fishball produced from sorted by-catch. Various other products using washed minced fish were developed and promoted. They included fish fingers and fish sausage.

Since 1983, surimi technology has been adopted throughout the world. In Thailand the surimi industry started in 1970.

Surimi technology is a package of imported technology comprising machinery, techniques and technologist. The technology was adapted to suit the local species. Machinery comes from two sources; Japan and Taiwan. The two types have different layout and different design for washing tanks. A refiner will gradually replace the strainer because a strainer causes a temperature elevation of 3-4°C. Polyphosphates (about 0.3%) such as sodium polyphosphate, sodium-pyroposphate and sodium tripolyphosphate are used. Surimi without polyphosphate are also produced because of the market demand; however, it has short storage life. Quality control in the production line is of great importance.

Critical control points are as follow:

1. Freshness and temperature of fish.
2. Water
   - — temperature
   - — hardness
   - — pH
   - — metal content
   - — volume used
3. Time in washing.
4. Washed mince temperature.
5. Ingredients.
6. Freezing and storage temperature.
7. Plant sanitation.

At present, buyers set standards for Thai surimi based on the following qualities:

1. Gel strength.
2. Whiteness.
3. Imputities.
4. Microbiology.

Product development

Surimi is an intermediate product which can be used as raw material for various kind of products. Surimi is commonly divided into three grades AA, A and B according to gel strength and colour. AA grade will have over 1,000 gm. cm, A: over 7000, B: 500-700. Price varies according to grade. High grade surimi are all exported; however, competitive market-structure may force the utilization of high grade surimi to value added products prior to export. Various kind of products have been studied and introduced to producers and consumers — for instance fish finger, fish roll, fish noodle, fish *wonton* and fish sausage. However, no market testing has been done.

FTDD is now working on product diversification based on technologies available to the Thai food processing industry. Among these, sausage and canned products have the best prospects although marketing development still has to be done.

Surimi processing technology for the abundant supplies of pelagic fish, is being developed. However lack of equipment has retarded this development. Freshwater fish was also used in surimi production on a pilot scale.

Through its Analytical Research Subdivision, FTDD will set up a pilot imitation crabmeat plant for research and development. The facilities will later be available for use by the private sector. Research and development using various species such as threadfin bream, jew fish, sardine and lizard fish will be carried out in depth, to develop information for the use of the industry.

Future Development

Several topics in minced fish, surimi manufacturing and fabrication of minced fish and surimi based products need further study. Research areas that require further work include:

- Development of proper on-board storage systems to preserve fresh fish and handling of fish on shore. CSW should be encouraged to replace conventioinal ice storage system.
- Utilization of red meat fish in the form of minced fish product.
- Product development from surimi for local consumers.
- Heat sterilization of surimi products.
- Fabrication of surimi products.

Socioeconomic Factors

As statistical data on demand and supply of fish in the minced fish business (and as data on labour and income) are not available, the following section is based on interview data. It is generally felt that the development of the minced fish industry has contributed to overall social well-being as follows:

1. Increasing price of raw material

According to FMO (1977-1986), mode auctioning price of fish has been increasing by almost 50% especially threadfin bream and flatfish (See Table 3). In practice fish previously sold as trash fish are now gradually sorted out for surimi processing. The price has increased from 1.50 baht to at least 3.50 bahts.

However, competition for raw material has also occurred between surimi factories and cured fish processing factories.

2. Increasing employment

Labour was normally required in filleting houses preparing raw material for fishball factories. When the number of surimi factories expanded from three to eight in central Thailand with another three in southern part. The size of the workforce engaged in heading and gutting was estimated to increase from 350 people in 1980 to 1,200 people in 1987.

Not only surimi factories but also small-scale plants producing dried minced sheet (*satay* fish) have offered significant job increase in villages and towns where these facilities are located. It is estimated by one industry source that a labourer can earn, depending on experience, from 2000-4000 bahts a month.

3. Consumer benefits

Consumers up to now have sustained a bad impression of minced fish and fishball because of the raw material and other ingredients used

— notably the addition of borax in fishball. The new processing methods have no offensive odour, have good elasticity and offer better overall product quality and safety.

Fish mince can also be utilized in various forms which offer the industry new opportunities for product innovation.

Table 3. Price of outstanding fresh marine fish auctioned at Bangkok Fish Market, 1977-1986

Species		1977	1980	(BAHT/Kg.) 1982	1984	1986
	MIN	2	2	2	2	4
Hairtails	MAX	9	15	15	29	18
	MODE	4	8	12	12	13
	MIN	3	4	5	4	4
Wolf-Herrings	MAX	23	26	45	40	65
	MODE	12	14	23	18	17
	MIN	2	4	4	2	3
Trevallies	MAX	16	8	25	20	18
	MODE	7	12	14	12	12
	MIN	11	10	5	8	12
King mackerel	MAX	33	40	70	70	75
	MODE	24	24	35	45	50
	MIN	2	3	2	2	3
Croakers	MAX	17	18	22	23	30
	MODE	7	10	12	15	16
	MIN	2	2	2	2	3
Big-eyes	MAX	8	7	8	7	7
	MODE	4	6	5	5	6
	MIN	1	2	2	2	2
Monocle bream	MAX	5	5	10	16	10
	MODE	2	3	4	4	6
	MIN	2	3	3	3	3
Treadfin bream	MAX	19	12	18	18	18
	MODE	6	8	11	12	12
	MIN	2	2	2	2	2
Lizard fishes	MAX	6	7	8	8	9
	MODE	5	5	5	4	5
	MIN	2	3	3	3	4
Flatfishes	MAX	15	16	28	27	30
	MODE	7	8	17	20	20
	MIN	—	2	2	2	4
Scades	MAX	—	8	10	8	10
	MODE	—	6	7	5	7
	MIN	3	4	4	4	4
Conger eels	MAX	9	8	12	8	12
	MODE	6	6	10	6	10
	MIN	3	4	5	4	5
Barracuda	MAX	18	16	30	28	32
	MODE	10	12	20	20	25

Source: The Fish Marketing Organization Fisheries Record (1977-1986)

Technology Transfer

Since 1983 the Fishery Technological Development Division has communicated new methods of fishball production to all levels of fish processors through seminars and training courses. Technical assistance to processors are also provided upon request.

Transfer of technology is done at three levels:

1. Food processors

Seminars and workshops have been conducted for food processors in order to introduce utilization of by-catch, new processing methods, equipment as well as quality control program.

2. Consumers

A workshop was conducted to show consumers how to utilize and preserve fish mince, and to acquaint them with product development. Workshops were carried out through both mobile training and pilot scale operations.

3. Extension officer

Training covers utilization and preservation of fish. Minced fish processing is one of the topic discuss. An extension officer who is trained in the FTDD laboratory for 3-5 days will then approach consumers in their responsible area.

All training were done outside the regular programme because of lack of staff and budget: The workshop and seminar were done under the technical project. Extension work, especially mobile training and technical assistance, were done through aid programme.

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Satay Fish and Other Traditional Fish Products Development in Malaysia

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Introduction

Traditional fish processing in Malaysia utilized about 6-10% of the total fish landed annually and the pattern of fish utilization is mainly confined to traditional basic methods of curing namely drying, salting and fermentation. The fish used are mainly the under-utilized species comprising of trawl bycatch and the small pelagic species which are unsaleable or non-profitable when disposed in their fresh state.

In the 60's most of the traditional processing were done in the 'backyard factories' where the standard of hygiene and processing technique were generally low, resulting in products of relatively short shelf-life. Consequently, their market characteristics with regard to consumer preference and acceptance were very localised. Not only did they lack quality assurance but their supply was inconsistent as export commodities. As such, low priority was given to the traditional fish processing industry; it was also unimportant as a foreign exchange earner.

However, with the formulation of the New Economic Policy in 1971, with its main objective to eradicate poverty, policies, programmes and projects were designed amongst others to generate and expand opportunities as well as to increase the productivity of all those engaged in low productivity activities.

From this perspective, although traditional fish processing involved only a small portion of total fish landed, it was an important component of the artisanal fishermen's earnings. Thus it became equally important to the national economy since most of the processing was done by the fishermen's family members, each contributing a small but crucial portion to the nett household income. This enabled them to ride out periods of low income due to bad weather, seasonal fluctuations and poor catches.

New Licensing Policy

The introduction of the New Licensing Policy by the Department of Fisheries in 1982 with the objective of controlling and reducing fishing effort particularly in the inshore fishing areas demanded a broad spectrum of alternative employment opportunities to be established. Non-fishing employment opportunities are not readily available in the country but there is room in the resource based activities especially in 'non-fishing' fishery activities such as improvement of fish utilization, processing and marketing which would, at worst create some additional income and, if better reduce artisanal fishermen's dependence on fishing.

National Agricultural Policy

In line with the National Agricultural Policy introduced in 1984, a new perspective is added whereby the policy stresses on the rational maximal utilization of the nation's resources. The import values of fish and fishery products increased to approximately US$153 million in 1986 of which about 82% was imported for human consumption and about 18% was feed meal. The significance of these import figures is noted when compared to the post harvest losses. Official estimate of 20% loss of the nation's total landings in 1986, valued at US$111 million or roughly 113,000 mt shows them to be considerable and indicate both the extra financial benefit as well as nutritional benefit that could be made if they were controlled. To the nation's economy the loss is equivalent to 72% of fish and fishery products imported in the same year. Post harvest losses is currently a matter of serious concern.

With the formulation and development of the policies mentioned programmes and projects are being implemented based on an Integrated Development Approach to cover various aspects of production, post harvest handling and processing, quality control and market distribution. A comprehensive coverage

was presented in my country report and this paper will focus selectively, generally and briefly on the development that has been achieved in the traditional processing industry over the last two decades.

Satay Fish

Satay fish is a type of snack food utilizing the Yellow Goatfish (*Upeneus sulphureus,* Cuv.) locally called *'ikan biji nangka'* from the trawl by-catch. Two other species are also used but the product is inferior in quality and market value. Prior to their use for *satay* fish these species were utilized as fertilizer or reduced to fishmeal for incorporation into animal feed rations (Chee, 1980). In 1984 some 1,147 mt of this fish was landed in Peninsular Malaysia.

Production of *satay* fish originally started on the Island of Pangkor, situated off the West Coast of Peninsula Malaysia. Production on a smaller scale started in the State of Trengganu on the East Coast sometime in 1984 as a result of extension efforts by the Department of Fisheries. With the exception of a few establishments the majority of the processing units operate as 'backyard' industries.

The traditional method of *satay* fish processing is basically a simple process requiring very little technical know-how and little investment consisting mainly of a roller and oven for drying.

As commonly practised, processing of *satay* fish is done in two stages namely;

1. The Primary Processor; usually confined to women who bought the raw material from the trawl fishermen and after dressing and sundrying, the butterfly-fashioned pieces are sold to *satay* fish processors,
2. The Secondary Processor; usually entrepreneur who bought the dry pieces and finishes the processing into end product.

In the past few years several efforts were made to standardize the product's quality and to improve *satay* fish production by introducing mechanization, eg. a dehydrator which, additionally, improves absorption of the sauce before oven drying.

The use of a dehydrator provides a better drying rate under controlled conditions of temperature, relative humidity, and air velocity yielding a more standard product and increasing output since the processing is independent of the weather.

Satay fish provides a means of altering the utilization of small-sized underutilized species which otherwise is channelled towards fertilizer production, into food for human consumption, thereby reducing waste and increasing the protein consumption through snack food amongst the people.

Satay fish is well accepted by the consumers throughout the country and the supply of raw material is abundant in the East Coast of Peninsular Malaysia. The Department of Fisheries through its extension services conducted short courses on *satay* fish processing to enable the transfer of technology from the West Coast to the East Coast, with MARDI (Malaysian Agricultural Research and Development Institute) conducting research on processing and Bank Pertanian Malaysia together with LKIM (Fisheries Development Authority) providing the credit facilities and guidance on management.

Keropok

Keropok or crackers are popular snackfood in Malaysia made from either fresh fish, prawns or squid and starch, either topioca or sago starch. Pelagic species such as *'ikan parang' (Chirocentrus dorab), 'ikan tamban' (Clupea leiogaste)* or *'selayang' (Decapterus russellii)* are the main species used although several other species are also used.

Keropok production in Peninsular Malaysia, once confined to the coastal fishing areas along the East Coast especially in the States of Trengganu and Kelantan, has since the 70's been produced in small quantities (< 5%) in other states like Johore, Pahang, Kedah and Perak. *Keropok* production increased from 563 mt in 1971 to 6,163 mt in 1984 and is still growing as an important cottage industry in Malaysia.

The use of the traditional method of processing which is highly labour intensive is becoming less common. In order to capture a larger market, a majority of processors has incorporated some degree of mechanization into their processing method, enabling some improvement in production efficiency and end-product quality, such as the use of:-

a.	Mechanical blade mixer:	to obtain a homogenous mixing
b.	Aluminium/ stainless steel or water permeable casings:	to produce *keropok* of constant shape and size and reduce labour cost
c.	Steaming under ordinary pressure:	instead of cooking by boiling, to save on time and space
d.	Mechanical Slicer:	to produce *keropok* of even thickness, to save labour cost and time
e.	Mechanical Drier:	to control moisture content, prevent hardening and poor expansion characteristic, eliminate contamination during and after drying and,
f.	Better packaging material.	

Keropok of various sizes, shapes and colour and made from different kinds of fish are available in the market and export-quality *keropok* are sold to over 30 countries; the export market is still expanding and demand exceeds supply.

Dried/Salted Fish

Drying and salting are probably the oldest and most common of all food preservation methods for several reasons, namely;

1. It is the least expensive processing method,
2. Low capital costs, and
3. Cheaper end products, more within reach of low income groups.

There is a large number of dried/salted fish products, including jelly fish and some are export commodities such as dried jelly fish, few types of salted fish and dried anchovies.

Much of the sun dried and salt cured fish products produced in Malaysia are of very high quality, and some of the products, once the poor man's food and become 'luxury' items for low income groups (eg; dried anchovies at US$6.40/kg). Processing methods remains traditional. However there is scope for further development particularly in the improvement of onboard fish handling, better sanitation in processing establishments and in keeping quality (experiencing losses as high as 25% in quantity due to spoilage during storage).

Artificial drying has been tried to meet the demand for a more uniform quality of product and to enable continuous production in some localities most affected by weather fluctuations. This has not met with much success economically; moreover consumer acceptance of artificially dried fish was poor.

Belacan

Belacan or shrimp paste, a high-salt intermediate moisture food is a traditional preparation of salted and fermented minced shrimp of a tiny *Acetes* sp. It is well established as a widely consumed condiment in Malaysian cuisine and is normally added as a flavouring ingredient in local dishes.

The production of *belacan* still remains at cottage industry level and most of them established as family concerns. Main production areas are the coastal fishing villages along the West Coast of Peninsular Malaysia and in smaller quantities in the East Coast.

Some form of mechanization in the *belacan* production can be seen especially in the main production areas, and the product's packaging has improved considerably. *Belacan* production in 1984 was 2,818 mt and the export market in South East Asia as well as Hong Kong and Europe is well established.

Conclusion

Malaysia's fisheries development programme like that of most developing countries aims to step up production of fish as well as to increase incomes and standard of living of her fishing population. Apart from determining ways to tap the newly acquired resources in the Exclusive Economic Zone, finding the best ways of utilizing the catch already available to her is no less important. As far as fish processing is concerned, traditional methods still commend themselves as being the most generally applicable and the most likely to be successful.

Realising the constraints within the fish processing sector which are mainly technical and economy of scale in nature, efforts are being made to educate the processors, and to up-grade and even relocate the processing units to facili-

tate the introduction and transfer of technology. The aim is to process the available resources efficiently into high-quality end-products for human consumption thereby increasing the productivity of fishing household and minimizing post harvest losses.

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Effect of Trading Time on the Quality of Fish Traded at Navotas Fishing Port Complex

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Background Information About Navotas Fishing Port Complex

The Navotas Fishing Port Complex (NFPC) is the first fishing port and fish market complex placed under the exclusive jurisdiction, control and supervision of the Philippine Fisheries Development Authority (PFDA). Located in the North-eastern section of Manila Bay, it is the largest in the Philippines and in Southeast Asia and is the traditional landing place of commercial fishing boats operating in various fishing grounds.

The project required the reclamation of 67 hectares of land and the installation of essential facilities. It needed more than ₱88 million to become operational through negotiated-loan agreement with the Asian Development Bank (ADB). It construction spanned three years from August, 1973 to August, 1976 under the direction of the Bureau of Public Works (Ministry of Public Works and Highways).

Harbour operations officially commenced on 15 January 1977 while the market operations started on 3 April 1977.

Before the construction of the fishing port complex, fishing boats had to anchor some 1½ kilometers from the shore and wait for three days or more for the amphibian trucks to take the last tubs from the boat and bring them to the fish market. With the opening of the port, fish are now directly unloaded at the quayside alongside the new market halls.

The improved systems and procedures for harbour and market operations being implemented by the PFDA help in reducing the time required for fish and other aquatic products to reach consumers. Handling has also been considerably improved, resulting in better quality fish reaching the market everyday.

Port and Market Situation

Approximately 1050 fishing vessels use the NFPC. As in the past, Navotas still accounts for some 40% of total commerical fish landings in the country. It also supplies 80% of the total fish needs of Metro Manila.

An average of 20 vessels call port daily while the number of vessels inside the port is 200. The average volume traded is 600 mt of fish nightly.

There are at present 4 market halls used as sites of brisk market activities in the port. Market Halls One and Two have been in use since 13 April 1977, catering mostly to wholesale buyers. The former has an area of 20 x 200 m while the latter measures 20 x 100 m.

Market Hall Three measures 20 x 88 m while Market Hall Four is much smaller, covering an area of 10 x 56 m. Both were established to accommodate retail buyers.

Fish trading begins at 1800 hrs. It is done through whisper auction *(bulungan)* and is participated in by fish brokers and buyers. The brokers act as middlemen between the producers and the wholesale buyers. Each broker has an allocated area where he displays and sells fish on behalf of the fishing boat operators. During this process, the buyers whisper their bids to the broker who after evaluating several bids settles the sale of fish in favour of a particular buyer. The winning bidder in turn, sells it to the smaller buyers or retailers. For this effort and investments (the broker sometimes finance the operation of producers), they (the brokers) receive a commission ranging from 5 to 7% of the gross sales (Fig. 1).

At the harbour, fishing boats and fish carriers calling at the port day and night do the following in sequence:

a) Communicate to the harbour master their intention to berth,

b) Berth at the area specified by the harbour master, and

c) Unload their catch from the vessel to the trading floor.

Assessment of Fish Quality in the Trading Halls

The present study was conducted at the NFPC during trading hours. The first part of the study was conducted during daytime trading and the second part was done in the evening. Round scad *(Decapterus macrosoma)* was chosen for the study since it is most dominant species in terms of volume auctioned at the NFPC. The tubs of round scad was taken from the auction and the samples were evaluated using the sense of sight, smell and feel.

The quality control staff of NFPC assessed the quality of fish according to the scheme shown in Table 1.

Quality Standard Scheme

According to the scheme, fish are classified into four grades. Grade I, which consists of live fish, is not included in the list as live round scad are not available for the study.

Grade II (Commercial) — fresh fish, consists of iced or chilled fish used for commercial purposes; usually distributed to local markets for consumption; or processed into smoked, dried products, etc.

Grade III (Marginal) — slilghtly spoiled fish; marginal limit for consumption; processed into *patis* (fish sauce) and *bagoong* products.

Grade IV (off-grade) — spoiled fish; unfit for human consumption; distributed to fish meal processors.

Fig. 1. Fish distribution channel at the Navotas Fishing Port Complex (NFPC).

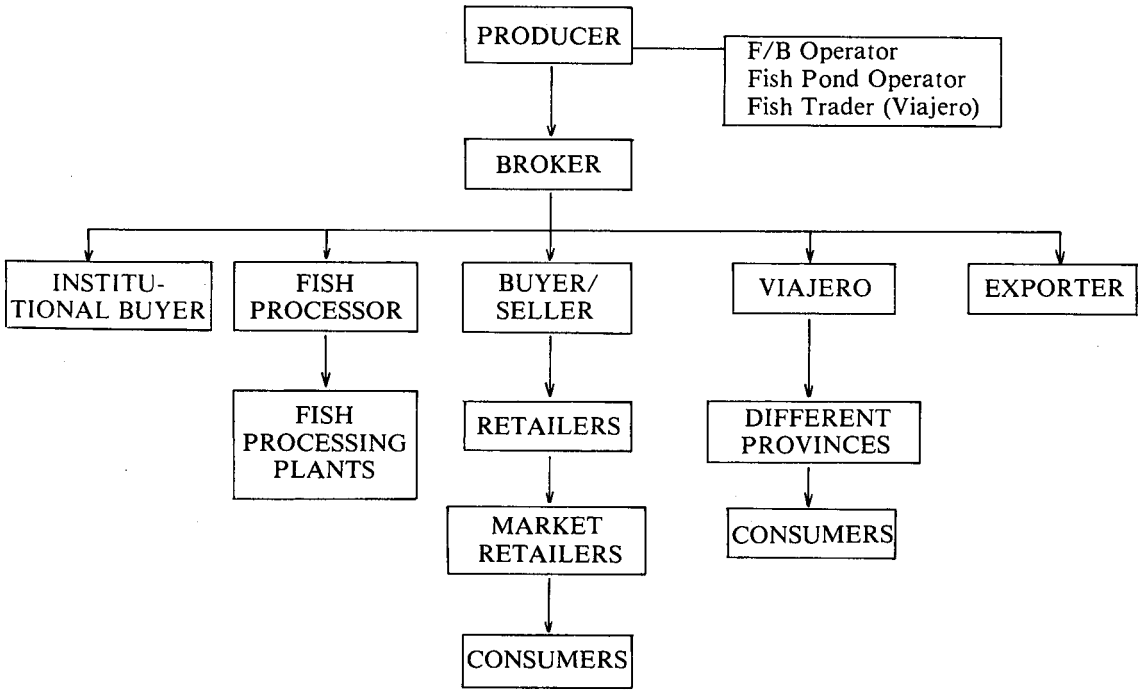

Table 1. Quality Standard Scheme

Characteristics	Grade I (Prime)	Grade II (Commercial)	Grade III (Marginal)	Grade Iv (Off Grade)
1. ODOUR	fresh, seaweedy odour	flat to slightly fishy odor	slightly stale but odour not rancid	sour; putrid or stale difinite off or foreign odour
2. GILLS	bright red	pale red to brown red	dark brown to yellow brown	yellow pale
3. EYES	clear bright bulging eyes	slightly sunken and cloudy white	sunken dull white	completely sunken, blood shot
4. DEGREE OF FIRMNESS	intact and firm belly wall; firm flesh and elastic	intact and firm belly wall, flesh not firm	soft belly wall	very soft, ruptured belly wall viscera protruding; depression made by finger remains
5. COLOUR	normal; clear, bright and shiny	colour slightly dull or faded	colour discolouration	colour discolouration; skin is abnormal; advanced stage of decomposition
6. PHYSICAL DAMAGE	free from mutilation, deformation and mechanical damage (such as loose scales, bruises and abrasions, cuts and punctures)	slight deformation, mutilation and/or mechanical damage	slight deformation and/or mechanical damage	badly mutilated and deformed due to bruises and other mechanical damage

Results of the Study

The study as shown in Table 2 reveals that there is a marked increase in the percentage for fresh fish Grade II and a corresponding decrease in Grades III and IV. Grade II increased by 57% while Grades II and IV decreased by 23% and 34% respectively.

The results indicated a reversal of the finding in the two studies. In the first study 29% are Grade II, 34% are Grade III and 37% are Grade IV. In the second study 86% are Grade II, 11% are Grade III and 3% are Grade IV.

The marked increase in the percentage of high quality fish indicates a marked improvement in the fish auctioned at the market. Thus, early trading truly proved to be a positive factor in slowing down the deterioration of fish. However, another factor that may have influenced the results of the study is the decrease in the quantity of fish catch due to a lean fishing season and the inclement weather.

The valuable results of the latest quality assessment has therefore provided the Authority with several insights. In its continuing endeavour to determine what factors affect fish quality, the PFDA considers studying the methods, techniques and practices of initial fish handling at the sea.

In intensifying quality control measures, the PFDA, aside from maintaining new trading hours, will enforce the following measures to improve fish quality:

(a) proper stacking of fish tubs *(baneras)* to avoid excessive pressure on the fish, (b) sufficient ice topping, (c) correct packing of fish to the brim, (d) use of non-rusty clean tubs *(baneras),* (e) and strict grouping of *baneras* according to the degree of freshness of the fish to allow minimum contact between fresh and spoiled fish.

With a better quality of fish at hand, it is hoped that people would get better return for their money. Table 2 shows the results of the study.

With the valuable result of the study, the PFDA management consulted the private sector on the proposed changes in trading hours viz from daytime to nightime. The association agreed to the proposal, after which bill boards were posted in the market halls informing the market participants of the change of schedule of trading time.

Conclusion

The PFDA shall maintain the present

Table 2. Shows the result of the study in terms of percentage (%)

Daytime

Days	Grade II	Grade III	Grade IV
1	26%	32%	42%
2	23%	40%	37%
3	38%	30%	32%
Average	29%	34%	37%

Nightime

Days	Grade II	Grade III	Grade IV
1	88%	8%	4%
2	86%	11%	3%
3	84%	14%	2%
Average	86%	11%	3%

trading time in view of the following reasons:

1. Minimise spoilage brought about by lower temperature,
2. The delivery of fish to their different distribution channel is faster at night time due to the smooth flow of traffic thus reaching the consumers in fresh condition,
3. Buying habit of Filipino housewives favours the early part of the day,
4. Investment in different fish processing industry has been accelerated, and
5. Delivery cost of fish is much cheaper due to the lesser volume of ice needed during night transport.

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Microbiology in Quality Control: Cockle Depuration in Malaysia

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Introduction

The cockle industry in Malaysia is considered the largest in the world in terms of production. Cockles contribute about 13% of the total fishery production in 1984 and about 10% in 1985 (Annual Fisheries Statistics Malaysia).

The industry is expanding in terms of new areas being identified for culture. Currently about 4,000 to 5,000 hectares of mudflats along the west-coast of Peninsular Malaysia are being utilised for cockle culture as opposed to 2,085 hectares in 1981 (Ng, 1985; ASEAN Food-Handling Bureau, 1984).

However, this positive trend is in danger of being hampered by adverse reports linking food poisoning, infectious hepatitis and gastro-enteritis to the consumption of contaminated cockles.

Already there appears to be a decrease in demand for molluscs in general and cockles in particular for the past three years.

The Fisheries Department in recognising the problem and in its effort to gain back consumer's confidence, has embarked upon a programme to study the possibilities of purifying cockles prior to sale to the public. A pilot-scale depuration plant was established in June 1986 at the Fisheries Research Institute in conjunction with the ASEAN Food-Handling Bureau. Apart from equipment purchased by AFHB a Consultant was also engaged to help set up the depuration system and initiate bacteriological monitoring of the depuration process.

The Depuration System

The design is based on that described by Ayres (1978) who was also the project consultant. Basically, the system is of the high-density recirculating type utilising ultraviolet lamps as the source for sterilisation.

Prerequisite Studies

The physiological requirements of the cockles in terms of preferred salinity was determined prior to start of the depuration studies.

The same applies for efficiency studies of the ultraviolet lamps.

Bacteriological Methodology

The contamination levels of the cockles were estimated using the Most Probable Number Techniques. However, the culture media and incubation period were modified. Minerals Modified Glutamate Broth (OXOID) and an incubation period of 18-24 hours at 44.5°C were effected.

As for the lamp efficiency studies, Membrane Filtration was used in conjunction with Membrane Enriched Lauryl Sulphate Broth. The incubation period being 18-24 hours at 44.5°C using a water-bath.

Parameters Studied

1. Effect of time on purification.
2. Effect of stocking density on rate of depuration.
3. Effect of processing time on mortality.
4. Effect of handling/transport time on mortality before and after depuration.

Conclusions and Recommendations

Studies show that purification to acceptable bacteriological limits could be achieved within 36 hours.

Cockles to be depurated should be freshly harvested and not more than 1 day old post-harvest to avoid high mortality during and after depuration.

The system has been shown to be able to handle a stocking density of 160 kg/tonne seawater or 37 kg/sq. m. These compare favourably with figures quoted for oysters and mussels, that is, 100 kg/tonne seawater or 30 kg/sq. m.

The extra costs incurred was 3 sen/kg for a 36 hour-run. However, labour costs were not accounted for.

Depurated cockles were shown to survive up to 2 days post-depuration and this would have a bearing on siting of the depuration plant.

It is feasible to locate smaller units in hotels, restaurants and supermarkets within West Malaysia. It is also feasibel for exporters to Singapore and Thailand to establish such units too.

Future Directions

The next logical step would be to set up a purification plant based on the pilot study but on a semi-commercial scale.

Purification studies would be extended to cover other bivalves such as mussels and oysters.

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Fermented Fish Products in Thailand

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Introduction

The use of fermentation techniques are common traditional practices for the preservation of fish for food in Thailand. Salt or brine solution is the main ingredient used to preserve fish, shrimp, squid, mollusc, etc. The proportion of fish and salt vary from product to product. Also the processing time and temperature influence the quality of the end product. Fish sauce, shrimp paste, salted bowel, and *budu* can be made by adding salt to marine fish and many species of fresh water fish. The proportion of fish to salt depends on the size and initial quality of the fish. After salting and mixing, the product is kept tightly sealed and allowed to age. During the anaerobic fermentation period the product components will be autolysed by enzymatic reaction together with microorganism activities at around 38 ± 5°C. Then 5-10 percent of roasted ground rice or rice bran will be added, mixed well and kept in earthern jar after the carbohydrate source has been added. The pH of the product usually drops from 5.8 to 4.2-4.7 in 2-5 months during aging.

The objective of our studies was to identify conditions that speed up the fermentation process, and study factors that play an important role in determining the aroma, flavor and color of the finished fermentation products.

Fish/salt/carbohydrate products

Pla-ra is the most popular fermentation product in Thailand. It is used as a main dish in rural areas. 97% of the fresh water fish catch is normally used for fermented fish. Snakehead *(Ophicephalus striatus), pla-kra-dee (Trichogaster trichopterus* Pollus.), *pla-soi (Cyclochilichthus* sp.*)*, silvercarp *(Cirrhinus jullieni)* and *pla-ta-pien (Puntius gonionotus* Bleeker) are scaled, gutted, beheaded and chopped into small pieces and 20-25 percent salt is added. The fish-salt mixture is kept tightly scaled for 2-3 nights or up to a month in earthen jars and then about 5 percent rice bran or 10-15 percent of roasted ground rice is added and kept tightly sealed in earthen jar for 3-6 months during fermentation process; saturated brine is added to cover 3 inches above the top layer of the product (Chart 1). The fermentation process

Chart I. Processing of fermented fish *(Pla-ra)*

Snakehead, Goramy,
common carp, silver carp
catfish and selected marine fish
↓
scaling, gutting
chopping and washing
↓
Mix well with
25% salt, leave overnight
or several months
↓
Add 5-15% roasted
ground rice, rice bran;
keep tightly sealed
in earthen jar
↓
Age more than 2 months
for good quality
fermented fish
(pinkish-colour)

Table 1. Proximate analysis of *Pla-ra* (fermented fish) made from several species

Species used	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Calcium (%)	Phosphorus (%)
Snakehead	57.39	14.57	12.46	15.90	—	—
Climbing perch	60.56	11.00	4.50	20.84	3.75	6.24
Goramy	61.18	11.85	3.61	20.89	2.60	7.11
Pla-chao	47.49	16.60	30.03	4.16	1.29	4.07

will be hastened if less salt is used. When carbohydrate is added the fermentation activity will start; the carbohydrate will be converted to sugar by enzymatic reaction and the sugar will be converted into acid (lactic acid) or alcohol, and CO_2 gas will be released by lactic acid-producing bacteria. This environment together with the salt content also results in a partial preservation of the fish.

After *pla-ra* is kept tightly sealed in earthen jars for 1 month the typical characteristic pink colour and aromatic flavour is apparent; the texture and the taste of the *pla-ra* is indicated by the distinct slight acid flavour and saltiness and a pleasant odour. The longer the fermentation period the more apparent the aromatic flavour.

Quality

The quality of *pla-ra* depends on

a) species of fish used,

b) quality of fish used, and

c) techniques used in the fermentation process.

The proximate analysis of pla-ra mode from several species is shown as Table 1.

Characteristics of *Pla-ra* technology

a) It was found that good quality *pla-ra* will result if the proportion of salt to fish is 1 to 2 and the product is incubated at 25-30°C; this procedure will give a distinct aromatic flavour to the sauce.

b) Each species of fish will give a special flavour.

c) Use of a small amount of salt and a poor quality of fish will result in more spoilage. Marine fish (chub mackerel, scad, lizard, threadfin bream and anchovy) are used to produce *pla-ra* but they are not popular because of the trimethylamine odour. Also, the more *Proteus* sp. in the product the faster the oxygen in TMA-O will be used up by anaerobic spoilage microorganisms. The result is a bad odour resulting from using marine fish in fermentation products.

Acknowledgement

I would like to express my appreciation and thanks to USAID/Thailand and the Agricultural Technology Transfer Project which provided financial support and helped me overcome all problems and to Deputy Director Bung-Orn Saisithi of Department of Fisheries who gave me many useful ideas, and Dr R.A. Ralston, ATT project Consultant who devoted as much time as necessary to help, operate the project; and lastly thanks to all of my colleagues.

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Inventory of Fish Products in Southeast Asia

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Summary

In response to a request of the 17th Meeting of the SEAFDEC Council in 1984, MFRD undertook a compilation of fish products available in the region, the quality of the products and constraints to their marketing and promotion.

Questionnaires on products were sent to Brunei Darussalam, Indonesia, Malaysia, Philippines, Singapore and Thailand covering 11 product aspects.

The study showed that most quality problems were concentrated in the category of traditional products — particularly smoked, dried and fermented items.

No serious problems were found among cured, boiled and powdered products which in any case are produced in small quantities. Among canned products, high rejection rates in export markets is a source of concern. Apart from raw material shortages, no serious problems emerged on frozen products and fish meal.

Overall the compilers believe the compilation will be useful in identifying available products and highlighting certain problems. Since the problems are socio-economic as well as technical, the compilers believe they can best be tackled by local technologists working cooperatively with professional colleagues from throughout the region.

Discussion of Case Histories

DISCUSSION OF CASE HISTORIES

"A Case History of Fish Jelly Product Development in Sarawak, Malaysia"

Mr Hooi complimented the speaker and his government on the reported activities in Malaysia. In response to the request for further training of officers from Malaysia, he said that he would give it serious consideration.

Dr Amano noted that most of the participants shown in the slides were women. Mr Suhaili explained that the participants were mainly housewives from fishing villages who were taught to use the catch by their fishermen husbands, thereby generating more income for the family.

"Utilization of Trawl By-Catch for the Development of Surimi and Surimi-based Prducts (1979-1987)"

The paper was presented. There was no discussion.

"Development of Minced Fish Industry in Thailand"

Dr Amano noted the involvement of the Japanese and Taiwanese technicians in the surimi factories. He hoped that Thai technicians would have more impact to the industry in the future. He suggested that training for private personnel be provided by MFRD.

Dr Matsumoto asked if browning of surimi is a problem. The reply was that it is a major problem for producers. So is the quality of water used for leaching.

In response to a remark by Dr Amano about marketing trials of products, it was clarified that, presently, the capability of the Department is limited to the transfer of developed technology. Market testing has to be done by private sector themselves.

Mr Haniff asked what style of fish noodle was produced. The speaker replied that the product form is dried noodles with 30-50% fish mixed with wheat flour and sodium carbonate.

The speaker highlighted the low cost of fish fillets in Thailand. Dr Ng asked why the fillets were preferred over the headed and gutted fish in view of the higher yield of the latter. The speaker clarified that headed and gutted fish were used, and further explained that the mince obtained from the head and gutted fish were inferior in colour to those from fillets.

"Satay Fish and Other Traditional Fish Products Development in Malaysia"

The question was raised whether Malaysia, which is now exploiting to the Maximum Sustainable Yield level, has the potential to increase fish production. The answer was that exploitation of stocks in near-shore water was indeed at MSY level and that the potential for future production increases lies in resources in the offshore part of the Exclusive Economic Zone.

"Effect of Trading Time on the Quality of Fish Traded at Navotas Fishing Port Complex"

Noting that not much ice was used in handling fish in Navotas the Malaysian delegate asked if there was any ice making plant near the complex and if so what was its capacity. The answer was that the complex has an ice making plant of 300 mt/day capacity. In addition there are ice-plants supplying the fishing boat operations with an average capacity of 200 mt/day. The actual trading hours at the complex is 8.00 pm — 4.00 am, extended in the peak season to 8.00 am.

The Singapore delegate pointed out that the container used in holding fish has no drainage holes and that this could lead to contamination of fish. The speaker responded that the *baneras* have been the traditional container used for generations and that although different types have been tried at the complex they were not successful. Besides *baneras*, other types of traditional containers such as bamboo basket, wooden container are used. Styrofoam boxes are also used for long distance transportation of fish.

Ms Camu added that high density polyethylene containers have replaced the *banera* in some fishing ports.

"Microbiology in Quality Control: Cockle Depuration in Malaysia"

Dr Amano questioned the use of faecal coliform as an index in this study and if the microorganisms were identified. It was clarified that faecal coliform as a group is acceptable as a good index for contamination from sewage discharge.

Dr Amano also wished to know how the harmful microorganism could be detected. The speaker stated that as the cockles are commonly obtained from sewage-contaminated areas, the determination of faecal coliform is commonly done — usually within 24 hours. However other harmful microorganisms especially virus are difficult to detect and monitor routinely. Dr Sunarya agreed with Mr Ismail's approach. However it would be useful, he believed, to further identify the type of microorganisms concerned because of differences of resistance between faecal coliform and other microorganisms to ultraviolet radiation.

In response to an assertion by Mr Ismail, Mr Boey said that the Singapore Government had never proposed to ban the import of cockles from Malaysia, but had warned its consumers that food-borne diseases might be present in the raw cockles and that cockles should be thoroughly cooked before consumption.

Mr Boey commented that the depuration system is very useful since it provide depuration of cockles at an economical price of only M3c/kg. Mr Ismail pointed out that that figure covered only the cost of electricity.

"Fermented Fish Products in Thailand"

Dr Ng observed that most of the products discussed were of fish origin and inquired whether other raw materials are used for the fermentation. The reply was that small shrimp and mussels are also used but that the product type was different.

"Inventory of Fish Products in Southeast Asia"

The Chairman complimented Ms Ng on her publication and stressed its usefulness and importance for the development of fish products in the region. The Chairman also expressed his thanks to the respondents of the participating countries for providing the useful information.

GENERAL DISCUSSION OF CASE HISTORIES

In discussing the price of surimi, Thailand, as the only producing country in the region, quoted the price as varying from US$1.15-$1.23/kg for local use and US$1.46-$1.54/kg for export.

The delegate from Thailand said the country is facing a shortage of raw material and wondered whether frozen fish could be used.

Dr Matsumoto responded that the problem of raw materials also exists in the Japanese surimi industry, and therefore processing has to be done seasonally. He further commented that other species of

fish should be explored for use as raw material. Frozen fish of certain species could be used but will not produce good quality surimi.

Dr Amano agreed that other species should be used, especially those of underutilized species.

Work on the use of trawl by-catch was then discussed. Mr Udom reported that sorted by-catch has been used in a surimi production trial in Thailand, but that the quality of raw material needed to be improved. Sardine was also tried but the outcome — especially the colour — is not acceptable.

Mr Tan pointed out that MFRD has carried out a study on the use of by-catch in surimi production. Gel-forming ability of each species found in the by-catch was determined and suitability of each species was also identified. In selection of new species, he pointed that it is necessary to find those with good gel-forming ability and which occur in sufficient abundane for industrial use. From MFRD's experience, *Pentaprion* sp. (glass fish) could be used in surimi production but the supply of fish is low. This species is now used by local fish ball processors. Lizard fish could be another option but due to poor handling practices in this region, it gives poor quality surimi, although in Japan such species has been used for surimi production.

There was some discussion of the possible use of shark meat. Dr Amano said that trials carried out by Dr M Okada showed that the yield was low after leaching.

Dr Sunarya pointed out that some sharks species give products of very good gel strength.

Dr Matsumoto agreed and noted that in Japan shark meat is used directly (from fresh meat) for making *kamaboko.*

Mr Tan commented that for commercial production of surimi, fish processors in the region may not necessarily require the top quality surimi as used by the Japanese industry. Surimi processors should take this into consideration when producing surimi for use in the region.

Discussion on Fermented Products

Dr Amano suggested that to speed up the process and to produce a good quality product, it is essential to know the exact role of the enzymic and microbial activities. The Chairman responded that in some fermented products such as fish sauce, fish enzyme plays an important role at the initial stage; bacteria then took over at the final stage of fermentation. However there are still some fermented fish products for which it had still not been possible to pinpoint the fermentation activities. The following areas therefore should be investigated.

— Identification of enzymatic and microbial activities at each stage.

— Identification of the effect of species on taste, aroma and other characteristics of products.

— Methods to speed up fermentation process (which may include the percentage of salt used and the addition of enzymes).

Recommendations

RECOMMENDATIONS

General

Five topics of common interest under which cooperative efforts may be possible emerged from discussions at the Seminar:

1) Handling of raw materials.
2) Surimi and fish jelly products.
3) Traditional products.
4) Training and information dissemination.
5) Future seminars.

The following recommendations were made:-

Handling of Raw Materials

(a) To improve handling and reduce spoilage, local governments should provide improved cold storage and ice-making facilities at landing points to improve the quality of fish.

(b) More studies should be directed to on-board preservation methods.

Surimi and Fish Jelly Products

(a) Development of new products for each area based on available local resources, citing surimi as an example.

(b) Upgrading of the quality of products for both domestic and export markets.

(c) Use of by-catch and underutilized species for surimi production.

(d) Investigation of the use of surimi for making value-added products for local consumption as well as for export.

Traditional Products

(a) Development of simple, efficient processes for existing traditional products eg., development of cheap and simple dryers and mobile fishmeal dryer.

(b) Improvement of technology for the packaging of products — especially traditional products.

(c) Assessment of fish processing methods to solve problems and to make improvements, eg., study on fermentation chemistry.

Training and Information Dissemination

(a) More training programmes in fish handling.

(b) Compilation of a directory of fish processing plants in the region.

(c) Regular updating of information (eg., on new methods, equipment and products) in the Inventory of Southeast Asian Fish Products.

Future Seminars

It was recommended that seminars on fisheries post-harvest technology be organised regularly to review MFRD activities and to exchange information on fisheries post-harvest technology development in the region. Also that a prize or award be instituted to be known as "The Amano Award". The Award would be given to the presentator of the best report at the seminars recommended above.

Appendices

SEMINAR PROGRAMME

28 October

9.00 — 10.00 am
Keynote Lecture

10.30 — 11.00 am
Country Report — Indonesia

11.00 — 11.30 am
Country Report — Malaysia

11.30 — 12.00 pm
Country Report — Philippines

12.00 — 12.30 pm
Country Report — Singapore

12.30 — 1.00 pm
Country Report — Thailand

2.30 — 3.00 pm
Discussion on Country Reports

3.00 — 3.30 pm
Resource Paper I

4.00 — 4.30 pm
Resource Paper II

29 October

9.00 — 9.30 am
Resource Paper III

9.30 — 10.00 am
Resource Paper IV

10.30 — 11.00 am
Case History — Malaysia I

11.00 — 11.30 am
Case History — Singapore I

11.30 — 12.00 pm
Case History — Thailand I

12.00 — 12.30 pm
Case History — Malaysia II

29 October

2.00 — 2.30 pm
Case History — Philippines

2.30 — 3.00 pm
Case History — Malaysia III

3.30 — 4.00 pm
Case History — Thailand II

4.00 — 4.30 pm
Case History — Singapore II

4.30 — 5.00 pm
Discussion

30 October

9.00 — 10.30 am
Discussions on Recommendation

11.00 — 5.00 pm
Drafting Committee Meeting

31 October

9.00 — 10.30 am
Adoption of Report

Closing Ceremony

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