

Advances in Fish Processing Technology in Thailand in Relation to Quality Management

SIRILAK SUWANRANGSI

Chief, Fish Inspection Center (Bangkok)
Fish Inspection and Quality Control Division,
Department of Fisheries, Thailand

Abstract

Fish and fishery products are important sources of food and are economically important to Thailand. Though marine fisheries production has become stagnant in the past decade, output is supplemented by both fresh water and coastal aquaculture production. Total fisheries production in 1993 was reported to be 3.4 million tonnes, of which aquaculture fisheries accounted for 9.7 %. The consumption of fishery products especially seafood is probably a result of the country's high economic performance. The upturn in fish processing industries and the Department of Fisheries' HACCP-based inspection program were recognized in the region and internationally in the past five years. Consequently, Thailand has become, by value, the largest fish exporting country in 1993 and 1994.

Processing technology is being developed to meet market demands for quality, safety and wholesomeness. Preservation technology for dried and fermented products is upgraded utilizing modern equipment and technology to extend shelf life and to improve standard for wholesomeness. While technology involving value-added products are developed locally for industrial scale production, processing technology is also being developed for dried, chilled, frozen, canned, retort-pouched and comminuted products. Quality management becomes the most concern of the fish processing industry. The Hazard Analysis and Critical Control Point (HACCP) based inspection system was enforced as mandatory for fish exporting companies in January 1996. Inspection techniques, monitoring and verification procedures are developed to strengthen the implementation of HACCP quality assurance program by the industries. Fish inspection for quality assurance has been focussed on meeting with international standards. New inspection laboratories and scheme for raw material control were established to employ the latest techniques to assure quality and safety of products and raw materials to be used for processing.

The Government has put strong emphasis on quality management program for the industry. In the 8th National Economic and Development

plan (1997 - 2001), the Department of Fisheries will continue projects to accelerate the development of quality products and quality system, to maintain the supply of safe and quality fishery products to local and international market and to resolve problems faced by the industry.

Introduction

The fish and fishery products industry of Thailand has grown into one of the country's major economic key areas. The fishing fleet of Thailand produces resources for both local and international markets; although marine fisheries resources have been declining it is still important to the development of the industry. Freshwater fisheries production continues to impact on local consumption and small scale processors, producing traditional products. The efforts of various government agencies to encourage better utilization of fishery resources for local consumption has resulted in the growth of a number of villages producing freshwater fish and fishery products.

Export of fish and fishery products affect both the economy and the development of technology. The fish export industry generate foreign income and create jobs for fishermen, fish handlers, traders, workers, technicians and administration at various levels. The export industry is relatively big in scale and production, with each exporter employing about 550 workers on the average. Their production capacity range from 5 to 150 tonnes per day. Their export has been valued at approximately \$ US 4 billion since 1993. The export demand has urged the industry to develop new technology with the government and through joint ventures. Though the industry faced problems in relation to raw materials, standards and regulations on product quality and quality systems, they are able to adjust to the changes and adapted successfully rather rapidly in cooperation with the government. The industry should be credited for the technology innovation, their implementation of HACCP program and their initiatives in market penetration.

The government has been playing a supporting role in the development of the industry.

Research and development on product quality, safety and new product development have been conducted. In the area of quality management, Thailand has fish inspection system recognized internationally. The HACCP-based inspection program of the Department of Fisheries is a key factor to the success in market development as much as the cooperative efforts of various Government agencies to support the industry through research findings, inspection services, information services on marketing, standards and other trade issues.

This paper reviews the growth of the Thai fisheries industry emphasizing the technological development and quality management aspects in Government and industry, based on information obtain through statistical information and reports of Government and private industries association. Information from inspections carried out by the Department 's inspection services and preliminary reports on quality assurance projects conducted by technologists of inspection and research institutes are also presented.

Fishery Production

Total fisheries production from 1983 to 1993 showed an increase from 2.3 to 3.4 million tonnes (Table 1). Aquaculture is still contributing to this increase. In 1993, the most recent year for which official statistics are available (Department of Fisheries, 1996), capture fisheries both inland and marine totalled approximately 2.9 million tonnes, while coastal and freshwater aquaculture fisheries was as high as 457,000 tonnes. While captured fisheries is thought to be exploited at close to its upper limit, aquaculture has increased dramatically from 45,000 tonnes in 1983 to 300,000 tonnes in 1993. The estimated production of cultured black tiger shrimp alone in 1994 and 1995 were 263,000 tonnes and 280,000 tonnes respectively while marine shrimp production were 100,00 and 105,000 tonnes. The estimates for 1994/5 showed that cultured production of shrimp accounted for about 73 % rising from about 52% in 1989 (Table 2).

Table 3 showed the value of total production from 1983 to 1993. The value has increased substantially from 1983 to 1993, from US\$769 million to US\$3,136 million (Table 3); in 1993 aquaculture held a record of US\$1,508 million.

Major Species Composition

Table 4 showed the composition of marine and freshwater fisheries production. As for marine fisheries in 1993, fish accounted for 79 %,

while shrimp, cephalopods and mollusk were 11%, 5 % and 4% respectively. For freshwater fisheries in 1993, fish accounted for 97% of production, while *Macrobrachium* shrimp accounted for 3%.

The increase in the production of each major species group from 1989 was rather low; production of cephalopods fluctuated, while freshwater fish and marine shrimp increased at the rate of 69.7% and 68.6% respectively (Table 4).

The growth of freshwater fish production was substantial due to the Department of Fisheries's program on village, school and community ponds; this production is a source of protein supply for people in the northeastern and north of Thailand.

Utilization of Fishery Resources

Table 5 showed the utilization of marine catch by types of fish processing. The total volume of fish processed in 1993 was approximately 3.3 million tonnes. In 1993, fish meal processors utilized 42% of the resources, canneries ranked second utilizing 27%, freezing plants ranked third utilizing 25%, followed by traditional products, such as salted fish, fish sauce and dried squid, which utilized only 5 % of overall resources (Fig. 1).

It was noted that utilization of resource for freezing increased gradually, except in 1991, while the use of fish resources for canning, smoking, fish salting, shrimp, shellfish and squid drying, fish ball, fish cracker and fish meal processing have started to drop in 1993. The utilization of catch for traditional products in 1993 was salted fish (31%), fish sauce (23%), dried squid (20%), dried shrimp (19%), fish ball (3%) and equal amounts for dried shellfish, smoking and fish/shrimp cracker (1% each, Fig. 2).

Table 6 showed the number of fish processing plants for types of processors. Records of 1983 to 1993 of the Department of Fisheries revealed that the number of freezing plants and canneries were increasing, while fish meal establishments was decreasing. The freezing plants and canneries in Thailand are of industrial scale, each employing from 150 to 2,700 workers.

There is a large number of traditional fish processors. It should be noted that most processors are of small scale and produce products mainly for local consumption, and only some of those, eg., fish sauce establishments, are of industrial scale producing products both for domestic and overseas markets. Each processor employs fewer than 40 people.

Foreign Trade

In 1993 Thailand emerged as the number one exporter of edible fishery products in the world fisheries market with export amounting to US \$ 3.64 billion as against US \$ 2.2 billion in 1989 (Table 7). The Department of Fisheries further reported the export earnings for 1994 and 1995 to be at \$ US 4.4 and 4.6 billion, respectively. Though the value of export continues to increase, the growth rate of export by volume was declining from 21% in 1989 to 5.7% in 1995. Total import in 1995 was \$ US 876,988 million, the rate of import has been decreasing since 1992. This was particularly affected by the amount of frozen tuna imported for canning.

Table 8 showed the value of trade with major trading partners, as reported by the Department of Fisheries (DOF, 1996). The export to USA, EU and Canada increased significantly. The major markets for Thai fisheries products in 1994 remain to be Japan (39%), USA (32%), European Union (14%), Canada (4%), Australia (2%) and others (5%) which include ASEAN members, and new markets such as China, Eastern Europe, Middle East, South America and African countries (Fig. 3). Among ASEAN countries, Singapore is a major outlet, importing US\$120 million worth from Thailand. In volume, Thailand still supplied up to 65% of Malaysia's imported fish (Ferdouse, F. 1994).

The Ministry of Agriculture and Cooperatives recorded the volume and value of various exported commodities, as shown in Table 9. The percentage by value of fish products exported in 1994 was frozen shrimp and shrimp products (48%), canned tuna and other seafood (36%), frozen fish fillet and minced fish products (8%), and frozen and processed cephalopods (7%). As for traditional products, a significant volume and value of dried shrimp, dried squid and fish sauce were exported.

Thailand imported a variety of fishery products, as shown in Table 10. Most of it was meant for further processing and for re-export. Import in 1994 of chilled and frozen fish valued at US\$553 million, consisted mainly of tuna. Frozen cephalopods were imported for further into frozen products for re-export. An interesting import item of frozen shrimp and small processed shrimp was valued at US\$34,120 consisting of shrimp for further processing into canned products and frozen value-added products. The value of imports of major fish and fishery products in 1984 was frozen fish (76%), frozen cephalopods (8%), frozen shrimps (5%) and others (11%). Import of fish and fishery products for domestic consumption was

increasing, but not yet significant probably because of high import duties. Tuna was also imported from fleets of many countries but mainly of Japan, Chinese Taipei, France, New Zealand, Canada, USA and the EU.

The Ministry of Commerce estimated the export of several seafoods from 1992 - 1995 by volume and value (Table 11). The 1996 figure is the target figure set for export of fishery products. The volume of production of processed seafood increased substantially in volume from 31,949 tonnes valued at US\$91 million in 1992 to 60,000 tonnes valued at US\$172 million in 1995. The volume of processed cephalopods was also increasing during the period. These figures confirmed that the output of value-added products have increased. The percentage of Thailand's top ten fishery products exported by value in 1995 was frozen shrimp (53%), canned tuna (17%), frozen cephalopods (8%), fillet/minced fish (6%), canned pet food (5%), various processed seafood products (5%), frozen whole fish (3%), fish sauce (2%), and dried fish products (1%, Fig. 4). The export of these commodities significantly improved the standard of processing technology development and product quality of Thailand.

Post-Harvest Technology

Thailand has been active in the area of post-harvest technology research and development for many years; government institutes, research institutes and academia have been actively involved in technological development. The Department of Fisheries through the Fishery Technological Development Institute (FIQD, 1995) has been conducting development research for:

- better utilization of fisheries resources, for example by-catch and fresh water species
- product development from local freshwater and marine species
- preservation of fishery products and extension of shelf life of fresh and preserved products
- process development for dried and fermented products
- packaging development for various types of fishery products including the use of plastic and laminated film
- improvement of handling techniques for fresh and chilled fish and shellfish
- biotechnology research involving chitin and chitosan production and utilization of wastes for flavours

The technology and information gained were used in the department's extension program to small-scale village and women's cooperative

groups resulting in the increase in home processing and small scale production for domestic sales. The capabilities developed were also used in providing technical consultation to the traditional fish product export industry to develop and improve products to meet requirements of importing countries and the demand for safe and wholesome products for the domestic market.

In the late 1980s, quality management became the most important focus of the fish processing industry. The Hazard Analysis and Critical Control Point (HACCP)-based inspection system was encouraged in international fish trade. Thailand enforced the HACCP - inspection system as mandatory for fish exporting companies in January 1996. Inspection techniques, monitoring and verification procedures are developed to strengthen the implementation of HACCP quality assurance program by the industries. Quality assurance in fish inspection laboratory to meet ISO/IEC Guide 25 or EN 45000 has been a focus. New inspection laboratories and raw material control units were established to employ advanced determination techniques to assure quality and safety of products and raw material to be used in processing. The government has put strong emphasis on quality management program for the industry (Suwanrangsri, 1996).

Quality control research emphasised on :

- development of techniques for quality evaluation, which includes development of sensory techniques, sensory profiles for various fishery products and establishment of critical limits for sensory quality determination
- suitable quality index for determining quality and safety of fish and fishery products, which also include development and validation of methodology
- contaminants level monitoring which include natural toxin, heavy metal content and bacterial contamination in fish and fishery products
- establishment of Good Manufacturing Practices for handling and processing of fish and fishery products

- establishment of HACCP system for the quality management of fish and fishery products
- establishment of Good Laboratory Techniques for fish inspection laboratories

The technical capabilities developed was used in the improvement of inspection procedures (Fish Inspection and Quality Control Division, 1995). Information gained were also used for risk assessment, establishment of critical limits, monitoring procedures, corrective action and verification procedures to support the industry in implementing the HACCP program.

Review of technology development by industry

Processing technology is continually developed to meet market demand for quality, safety and wholesomeness. Since 1991, the industry has gradually switched to semi-automation process with the aim to produce better yield, better quality and faster production cycle. In the early 1990s, technology involving value-added products were developed both through joint venture and innovation by the Thai processors for industrial-scale production. Processing technology was developed and improved for frozen, canned, retort pouch and comminuted products. Preservation technology for dried and fermented products were upgraded utilizing modern equipment and technology to extend shelf life and to improve standard for wholesomeness.

Frozen Products

Thailand is well equipped technologically for frozen fishery products. A large variety of products is being produced from basic labour-intensive technology to advanced automation technology. The factories are of industrial scale employing from 100 up to 2,000 workers. Frozen fishery product processors engage the following number of workers :

No. employees	< 100	101 - 300	301 - 500	501 - 900	901 - 1,300	1,301-2,000	>2,001	Total
No. factories	16	31	20	21	16	11	7	122

Table 12 showed the number of processors of traditional frozen product and value added products. Production of value-added products is growing rapidly; an assessment of the company profiles of frozen product processors revealed that they also have the capacity to produce value added products.

1. Shrimp

Processing technology was upgraded to semi-automation methods in order to speed up production and to reduce human-sourced contamination. Equipment is being installed to replace workers and these include washing tanks, shrimp graders and shrimp peelers. The uses of

shrimp peelers was introduced in 1992 by processors but was discontinued because they did not prove economical. Improved grading tables and conveyor belts are now widely used. Since the Department of Fisheries is stringent in its requirement for plant sanitation and good manufacturing practices (such as the use of chlorine in washing or in dips for raw material), the industry has also introduced new technologies such as ozonized water. Modern freezing technology was introduced in 1992; there are several methods employed, such as nitrogen and carbon dioxide freezer, spiral freezer for individual quick frozen products.

Processing technology for the production of cooked, prepared and ready-to-cook as well as ready to eat products was introduced extensively in early 1990s; various new products were then developed to reach out to both local and international markets. Among the various products, fishery products became popular and these were combination shrimp, squid with vegetables, or bakery products, including the development of Thai recipe TV-dinner products. Automated production was used to lessen human contamination and cookers were introduced to speed up processes as well as to improve yield. The in-plant research on suitable cooking time and temperature to prevent *Listeria monocytogenes* contamination was required by the Department of Fisheries, as part of the HACCP plan. For cooked and ready to eat product, the establishment of a sanitary zone separating raw and cooked process is required. Good Manufacturing Practices for the control of *Listeria monocytogenes* developed by Canada was recommended to processors of cooked and prepared shrimp by the Fish Inspection and Quality Control Division.

New packaging system are being used. The most popular is vacuum packing for supermarket products. TV-dinner and microwavable packs are also used.

To date, 60% of freezing plants is capable of producing cooked, prepared, ready-to-cook and ready to eat frozen products (Thai Frozen Foods Association, 1995).

The industry has, since 1992 faced problems relating to veterinary drugs and chemical residues. Research has been conducted in the area of detection and screening methods for various types of drugs. The Department of Fisheries has introduced a HACCP-based quality control program, extending from farm to processing plant, as a preventive measure for drug and chemical residue in aquaculture shrimp (Tookvinas and Suwanrangsi, 1996).

2. Cephalopods

There has been no technological changes in cephalopods processing. The supply of cephalopods has fluctuated. There are four main markets for the products, viz Japan, Italy, Spain and USA. The need for technology is in improvement to cleaning and de-skinning. If technology could be developed, it would minimize the risk of contamination from humans and water used in cleaning as well as speed up the process. Cephalopods are used in seafood mixes, where demand is growing. There are currently 45 processors manufacturing frozen cephalopods and among them are 10 processors actively producing seafood mix products.

3. Fish fillet

The production of fish fillet utilized both local and imported fish such as cod, pollock, yellow fin sole and flounder. A process normally begins from thawing using bubble thawing process, de-skinning, filleting, inspection of fillet, packing and freezing. Filleting is still a labour intensive process, since it requires human skill for yield and inspection against parasites. Products are packed in individually quick frozen fillets or block frozen. Currently, there are 33 factories producing fish fillet for export. Breaded products produced; machinery is commonly used for battered and breaded products.

4. Surimi and surimi-based products

Surimi production in Thailand utilizes mainly local species. Surimi is exported as well as utilized in crab meat analogue products. Since 1992, the world market for surimi has faced a down turn and production by Thailand decreased significantly. There is no new technology utilized in surimi production, except the use of various types of cryoprotectants. The surimi industry faces stringent demands for processing hygiene and product wholesomeness imposed by the Department of Fisheries. To date, there are 12 active processors.

Imitation crab meat processing grew significantly in Thailand since 1991. Presently, there are 7 imitation crab meat processors. Japanese technology was employed with improvement of processing line to speed up process. Microwave thawing technique has been introduced. Likewise, in the cooked shrimp process, the establishment of a sanitary zone is required as well as the improvement of handling after cooking to prevent recontamination. Several types of analogue products were developed, including a dried surimi-based product.

5. Other frozen fishery products

Among existing freezing plants, there are at least 14 factories which have diversified their production to produce a variety of products from crab, freshwater fish, freshwater shrimp and cold water shrimp. Some are also capable of manufacturing value-added products from those species.

6. Fish Sausage and Ham

A major tuna cannery has successfully innovated the technology for producing sausage and ham from tuna in 1995. Yellow fin was utilized for fish sausage, ham and various flavoured sausages. The process was developed from meat sausage techniques, with the aim of producing products resembling chicken sausage. The product gradually gained market acceptance, even though competition from pork sausage remained strong. Further production and handling techniques are being developed for improvement of shelf life during transportation and marketing.

Canned Fishery Products

Canned fishery products are classified as low acid canned food items. Technology development mostly concerned quality assurance and product safety, packaging development and new product development. In 1996, there were 22 active tuna packers and 30 other canned seafood packers and traders. The President of the Thai Food Processors Association has divided the various stages of the development of the canning industry into :

- Initial stage (1970-1973): Development of canning technology and improvement of process to meet international standard.
- Development and export stage (1974 - 1979): Development of export of canned tuna, shrimp and baby clam.
- Development, production expansion and marketing stage (1980-1985): Dramatic increase in processing facilities, increasing at approximately 10 plants/year. Export rose steadily. Attention was paid to producing quality products.
- Quality improvement stage (1986-1990): Many changes in product quality, training, research and production facilities because of market demands.

- Production and market competition stage (from 1991 onward): Since 1991, competition in both areas has become strong. Raw material supply has fluctuated and decreased. Production facilities have to adapt and improve to meet international trade standards (Thai Food Processors Association, 1995).

1. Canned tuna

Canned tuna is a standard item in the international market. Products are packed in various sizes and in various packing medium, viz oil, brine, water, vegetable broth. Different types of tuna species are used, including skipjack, yellow fin and albacore which were imported from Japan, Taiwan, USA and EU purse seiners. Local tuna species are also used.

To date, technology improvement in the Thai tuna industry emphasises heavily on quality, safety, yield improvement and new product development.

From a quality point of view, the main concerns of industry are to control the decomposition of tuna and its product in order to produce a product that meets the demands on quality by the US and Canadian markets. The Department of Fisheries, since 1992 has introduced Good Manufacturing Practices for canned tuna specifically to resolve problems relating to product decomposition which mainly involve controls of :

- Grading standard for raw tuna
- Thawing temperature control
- Control of delay time after thawing, and
- Control of lag time for loin cleaning

In terms of product safety, stringent control of thermal processing and post-process control are necessary. As in the case of all other low acid canned food requirements, the processors are required to establish thermal process schedules for each product. The packers have improved their capability to conduct their own studies.

Technology development also emphasised yield improvement through the use of spray water cooling techniques to quickly reduce temperatures after pre-cooking, the introduction of different systems of filling machines or mechanical butchering and the use of hydrolyzed vegetable protein.

As for canning, more and more of the two-piece metal cans of various sizes and the easy to open end cans are being used. Retort pouch products, which became popular in the Japanese market, are produced by 6 of the 22 tuna canneries. Specific technology and control of packaging materials are employed.

Product development in tuna industry has progressed significantly since 1994 with the aim to introduce canned tuna to the local market and to improve marketing through competitive pricing in the world markets. To date, over 20 types of tuna based canned products are available, such as tuna spread, tuna salad, tuna in mayonnaise, tuna curry, tuna in chili sauce, etc. and these are sold in new packaging shapes and sizes.

2. Canned shrimp

Production technology for canned shrimp has emphasised quality improvement. The use of food additives e.g. sodium metabisulphite and EDTA have been of concern to importing countries such as USA and the European Union. The processing techniques have been changed and now use low temperature control and better handling of raw materials to solve problems relating to sensory quality of the products and to discontinue the use of prohibited food additives. Since the supply of sand shrimp has been decreasing, a large volume was imported, mainly from Vietnam.

3. Other Canned Seafood

The canning of sardine and mackerel progressed much slower than the above two commodities. This is due both to the lower market value of these products and the demands on quality from the destination of their markets are rather different. However, the industry faced the same stringent enforcement by the Department of Fisheries to maintain standard of production to meet hygiene and safety requirements.

Canned baby clam production was decreasing due to the shortage of raw materials. No technology development was observed.

Traditional products

There are cottage to village industries distributed country wide. Training courses are conducted by various government agencies, e.g. Department of Fisheries, Department of Agriculture Extension, Ministry of Industry, Ministry of Interior and Ministry of Defense to promote better utilization of resources available locally, and to uplift the livelihood of people in the provinces. Simple traditional product processing techniques are being introduced to promote utilization, consumption and sales to tourists and visitors. This has made the number of

processors in the official statistics rather high, even though the volume of raw material utilized, and products are rather low.

Technology improvement benefitted processors of industrial or medium sizes, resulting in their successful export thrusts since 1993. Quality control is the key area being developed, and a HACCP generic model was jointly developed with processors. The Department of Fisheries supports the implementation of the program by offering training and technical guidance.

Fish Sauce

Significant changes over the past five years in the fish sauce industry are the result of market demand for quality and wholesomeness. The industry has employed modern equipment for raw material handling, mixing and packaging. The salting process, though, is still done in concrete tanks but hygiene improvements are significant to meet and satisfy market demand. Packaging is the area of dramatic growth. The industry began implementing a HACCP program, as required by the Department of Fisheries; technical assistance were given to develop and implement the program.

Dried Products

Dried fish, squid and shrimp are major items in this category. Since market demand did not increase significantly, the industry developed only product forms and packaging. Dried seasoning product appears to be the new direction of development. One such innovation of dried product is dried imitation crab meat.

Fish Snack

Fish (shrimp, fish and squid) cracker and extruded fish snack products are in this category. Fish cracker production combining traditional process techniques, quality control and modern packing technology are keys to success in export market. The products are available in raw and ready to eat forms. Improvement of shelf life of ready to eat cracker is the key to successful marketing of the products.

Other Products

Chilli-based products consisting mainly dried or fermented shrimp and fish, products are popular locally and among travelers. The US and Europe are major markets.

Fish inspection

1. Traditional Fish Inspection System (1964-1990)

The Fish Inspection and Quality Control Division of the Department of Fisheries (DOF) is the main organization providing service to the export industry on fish inspection and quality assurance. The fish inspection and quality control services of the Division have been engaged mostly in preshipment inspection and facilities inspection, which are the principle means used by most governmental agencies in the world to control safety of food. The Fish Inspection and Quality Control Division of the DOF inspects fishery products for compliance with international standards for export and where applicable, the importers' requirements related to health, safety, quality, identity, process and handling. Product and processing plants intending to export to North American and European markets are subjected to inspection by DOF. The department has established a list of approved fish processing plants for export to those markets since 1989. There are approximately 250 packers and traders registered to export fish and fishery products, among these DOF approved a total of 193 processors in 1996. Table 13 showed the number of approved establishments of the DOF from 1992 - 1996. The department was recognized by many countries for her inspection system and the list has been provided to those countries. Since 1994, the department has been recognized as the competent authority to conduct fish inspection for the European Union; it was also then that the department included in the program approval of traditional products processors. To date, the inspection services covering fishery products are intended for export only. The Ministry of Public Health has jurisdiction over products for domestic markets.

The department recognized that traditional inspection schemes have certain limitations. Inspection of facilities and operation are carried out with reference to various guidelines, standards and Codes of Practices. In many cases these documents fail to indicate the relative importance of various requirements and the requirements are stated in very imprecise terms such as "satisfactory, adequate, suitable, if necessary," etc.. This leaves interpretation to the inspector who may place too much emphasis on relatively unimportant factors and thus increase cost without reducing hazard. Microbiological testing also has some limitations as a control option. There are constraints of time, difficulties

relating to sampling, analytical methods and use of indicator organisms.

2. HACCP-based Fish Inspection Program (1991-present)

The Department of Fisheries recognized the need to direct the inspection system to a preventive system based on HACCP. Therefore, in 1991 the DOF implemented voluntary HACCP fish inspection programs. The program involves with reviewing inspection procedures and establishing HACCP procedures in the inspection agency, pilot HACCP implementation by the industry and training for inspectors and industry. Inspection procedures of facilities and operation were revised with reference to CODEX guidelines, standards and Codes of Practices on HACCP and GMP. The inspection rating scale indicates very precise terms such as critical, serious, major and minor, which relate to health and safety, quality and good manufacturing practices. Instruction and training are given to inspectors to emphasize critical control points and problems relating to health and safety. Generic HACCP plans have been developed for major commodities, through studies, research, workshops and working groups with the industry. Guidelines for development of documented programs or quality manuals have been provided and updated to meet with international guidelines and importing countries' requirements on HACCP. Close monitoring of the processing industry's performance in HACCP programs have been carried out by inspection of facilities, control at critical control points, record review and quality program verification.

In 1996, the program is mandatory for approved fish processors under jurisdiction of the department. Approved processors must have HACCP-program implemented, documented and verified by the department. HACCP inspection procedures are developed and updated. Inspection manuals are prepared.

3. HACCP Inspection Approaches

The DOF set a prerequisite program, which concern sanitation, hygiene control and GMPs as minimum requirements of HACCP-based quality management program, with monitoring, verification and enforcement done by the department. The program will ensure that processors have the capability to monitor their own performance against Thai Department of Fisheries and foreign country requirements and have the

ability to take appropriate corrective actions if and when required.

A generic HACCP program has been developed jointly by the DOF and representatives from industry. In many cases what the program demands is already being done; it can be best described as a confirmation of good manufacturing practices. Each processing establishment must develop a HACCP plan appropriate to its processing practice, hygiene and sanitation status.

The processors must identify hazards associated with the products and processing environment. Hazard analysis and risk assessment analysis should be conducted extensively. The industry is recommended to have basic sanitation, hygiene control and GMPs as a pre-requisite program; once the hazards can be controlled by these programs, critical control points can be easily identified using the Decision Tree and kept to a minimum to control product safety. By this approach, confusion between critical control points (CCP) and control points (CP) have been greatly reduced.

Guidelines for program development and documentation are also given. A handbook is available to industry in the local language.

4. Implementation of HACCP by industry

The interest of the industry in implementation of the program is very significant.

The department requires the program to be documented, verified and implemented. Therefore, the DOF has classified the various stages of implementation by the industry into 3 levels, recognizing that all fish processing establishments under the approved list already has sanitation, hygiene condition and processing practices meeting the requirement of DOF and that the principles of HACCP have already been applied by the Thai industry.

Stage 1. Initial development: these processors have already instituted control programs to ensure product safety and quality, the company has already identified hazards, established and implemented preventive measures, monitoring procedures, critical limits, corrective action and verification and a system of record-keeping and the program is in place. Documented HACCP plan is being formulated.

Stage 2. Development stage: the processors have already instituted a control program, identified hazards, established and implemented preventive measures, monitoring procedures, critical limits, corrective action and verification and a system of record keeping. Documented program is submitted to DOF for verification.

Stage 3. Fully implemented stage: the processors have HACCP plan fully functional and their documented program is already verified by DOF.

Processors have implemented HACCP programs and have submitted a quality control manual for verification by the DOF. Standard operational procedures for verification of HACCP program and industry have also been established by the Department.

As of 1 July 1996, 50% of the establishments have fully implemented HACCP, while 35 % are in development stage and 15 % are at initial stage.

Generally, traditional products processors, who are rather small scale producers, are at preliminary stage, requiring training and technical assistance from the department. Fish sauce processors however, have advanced in HACCP much quicker than the rest.

The department developed a three-day training course module on HACCP Application for the industry and fish inspector. Four training courses/year have been conducted for the local industry on the Principles and Application of HACCP (Suwanrangi, 1996). This includes development of a HACCP generic model for products as follows:

- Canned tuna
- Canned seafood (shrimp/crab meat)
- Frozen raw shrimp
- Frozen cooked shrimp
- Frozen battered and breaded shrimp
- Frozen fish fillet
- Frozen surimi/imitation crab meat
- Fish sauce
- Fermented fish products
- Dried fish products

The industry would use the model as a basis for the development of HACCP plan to suit each individual processor.

Supplementary courses on monitoring and verification procedures are also conducted.

A regional HACCP training course was conducted for government officers from 16 countries in the Asia Pacific region in November 1991.

5. Inspection laboratories

The Department of Fisheries currently operates 4 regional inspection centers. Each center consists of field facilities and inspection services and laboratory services. Laboratories are equipped

with facilities for determining physical, chemical and microbiological parameters. The laboratories operate under ISO/IEC Guide 25 and are now under the accreditation process with national and international laboratory accreditation bodies. Under this scheme, the laboratories maintain quality systems and documented manuals and operate according to established standard procedures from sample handling to certification. Laboratories participate in split sample testing program of Public Health Laboratory Services (PHLS) and Food Analysis Performance Assessment Scheme (FAPAS) of the United Kingdom and conduct regular collaborative study using standard reference materials with national and regional laboratories in ASEAN. The laboratories have experienced and trained personnel at different levels to conduct analyses for safety, quality and product conformity to market requirements. They also provide guidance to laboratories of the processing plants in order to perform testing and monitoring to meet international standards. Guidelines for establishment of fish quality control laboratory are published and freely available to the industry.

Problems Faced by the Industry

Although Thailand has been successful in technology innovation and export development, there are problems encountered by the industry and they are as follows :

1. Raw materials shortage and supply fluctuation

Since resources in Thai waters are overexploited, the industry has suffered raw materials shortage in cephalopods, demersal fish, crab, mollusk and marine shrimp. Raw materials have therefore been imported, but fluctuations in world catches have also affected the industry. Moreover, an increase in the number and the production capacity of these processors have made the situation worse. Aquaculture could supplement the need to a certain extent but the low production period in the dry season and sporadic runs of disease have affected the stability of supply to the industry. Growth in local consumers' demand, the result of better purchasing power, has also created competition for supply which has, in turn, driven up prices.

2. Barriers to trade

In the early 1990s, there were problems related to quality, health and hygiene regulation and importing countries requirements. However,

in the past 5 years, the industry and the government have diligently worked on the problem through introduction of HACCP and negotiation with importing countries. It is therefore believed that the above problems, which are technical barriers to trade, can be resolved with importing authorities; yet problems related to non-technical barriers grew much stronger, especially those concerned with the environment and tariff barriers.

3. Cost of production

Thailand continues to enjoy the blessing of cheap and skillful labour but the minimum wage has increased by 40% in the past 5 years. Moreover, utilities cost are escalating which make the industry less competitive in price. In addition, since Thailand is considered to have a developed fish processing status, import privileges now enjoyed may likely be terminated, thus making production cost much higher.

4. Information on standard and regulation of trading partners

As importing countries becoming more concerned with safety, quality and wholesomeness of the fishery products, new regulations have been imposed as well as new standards and action levels. However, access to information is limited in many countries'; there is no clear contact point for such information. The department has already implemented the program on Who is Who in Fish Inspection to identify contact points, but an improved system is needed to keep the industry and government up to date on information regarding changes to standards and regulations.

Government Policy

The Thai Government emphasized human resource development, rural development, poverty eradication and export promotion in its National Economic and Social Development Plan; this proved to be successful as the economic growth rate has been higher than 10 % since 1992.

In the 8th National Economic and Social Development Plan, the Department of Fisheries, in recognizing the problems faced by the industry in the area of post-harvest technology and inspection, has set priorities in the following areas :

- conduct a research and development program relating to safety and quality of fish products, product development and to develop technology to secure supply and reduce handling waste

- implement HACCP-based inspection program to strengthen capabilities in research and inspection services
- expansion of inspection and laboratory capabilities to the provinces to assure quality and safety of fishery products intended for export
- participation in international forums and programs relating to fish and fishery products
- establish Memorandum of Understanding or Mutual Recognition Agreement with trading partners
- conduct cooperative programs on FPHT and inspection with regional and international bodies
- establishment of national training and calibration centers on fishery technology
- establishment of integrated information system with trading partners

DOF Projects on Fishery Post Harvest Technology and Quality Management

1. Fishery Product Export Promotion Project (1996-2001)

The department has received US\$20 million from the government to implement this five-year project aimed at :

- maintaining Thai fish processing industry's capabilities in the production of quality and safe fish products which conform to international and importing countries standards
- improving technology involving production and quality control and product development
- securing supply of raw materials
- promoting the export of new commodities

Major activities of the project involves the establishment of a training and calibration center, specific research development projects on product development and quality improvement and negotiation on equivalency of fish inspection system with trading partners and promoting the export of new commodities e.g. aquarium fish.

2. Raw Material Quality Improvement and Inspection Project (1994 -1999)

The department has received \$US10 million from the Government to implement this five-year project aimed at establishing overall inspection control from raw material to end products. Major activities involve the establishment of raw material quality control centers in major aquaculture areas; strengthening of monitoring program and inspection of raw

materials from marine capture fisheries, environmental monitoring and establishment of three new regional fish inspection centers.

The Ministry of Commerce also supported the program of the Department of Fisheries on trade development and export promotion as follows :

a. Development of inspection linkages with major trading partners

Currently, the Department has a two-year collaborative program with the European Union. The program involves training and visits of inspectors in the EU member states, recruiting of specialists from EU member states and collaborative studies with EU member states on research and inspection activities.

b. Development of laboratory capabilities for accreditation

The program involves the development of standard procedures and documents the system for laboratories to meet with criteria of ISO/IEC Guide 25 and national and international laboratory accreditation bodies.

c. Quality improvement for specific fishery products

The program aims at resolving immediate quality and safety problems faced by exporters. It involves technical studies and joint workshops or training with trading partners.

In addition to these the department is actively involved in joint programs with foreign governments e.g. Canada and Japan, regional economic group e.g. ASEAN and APEC and international bodies e.g. FAO and UNDP.

The programs include :

- The ASEAN Canada Fisheries Post-harvest Technology Project - Phase II (1992 - 1997)
- APEC Project on Health and Quality Rules for Fish and Fishery Products (1995 - 1997)
- The Research Project on Quality Development for Fishery Products funded by Japanese International Cooperation Agency (1994-1998)

The department also participate in international programs to assist in the development of post-harvest technology and inspection system in developing countries.

Future Development

The Government has planned for Thailand to be a regional center for food processing. Therefore, the Department foresees the role of the agency in supporting the industry in maintaining the production, development of technology and human resource development as well as market development.

Its role in research would be directed towards product and technology development for local consumption as source of protein and to improve handling to reduce waste and spoilage, as well as new product development from freshwater species. Since the industry has shown its own capabilities in product technology development, the department will continue to work towards product development to strengthen the industry. The department will also conduct joint programs with other government institutes and universities to conduct research on fish handling, processing and quality control and provide information, budget and equipment to support those agencies to conduct research relevant to the interests of the Department.

Research on quality assessment and risk assessment will continue. Meanwhile, laboratories and research institutes of the department will be strengthened to meet international standards for accreditation.

Training of inspectors and quality controllers are planned; training centers covering processing, handling and quality control are being established, while training on key aspects are being conducted regularly for the industry.

The department will play an active role in the area of inspection and quality control. This is to satisfy the requirement of many countries which recognises only the government institution's role in inspection and quality control.

The department supports the harmonization of standards for fish and fishery products and the recognition of equivalency of systems. Therefore, it will work with countries, economic groups and international agencies in these areas.


The department will continue to work for mutual recognition agreements with trading partners to facilitate trade in fishery products. There is an urgent need to establish information linkages within the department and with trading partners.

In recognizing the expansion of international trade, health and safety aspects of fish and fishery products, the department will continue to cooperate with international organizations. Assistance to countries needing to establish and improve their post-harvest technology and inspection system is also included

in the plan, as well as to play an active role in the international forum in the development of technology on fish handling, processing and quality control.

Reference

- Center for Agriculture Statistics, 1996. Agriculture Statistics of Thailand Crop Year 1994/95. Office of Agriculture Economics. Ministry of Agriculture Cooperatives. Bangkok, Thailand.
- Department of Business Economics, 1995. Report of the Seminar on Export Target for 1996 (in Thai). Ministry of Commerce. Bangkok, Thailand.
- Department of Fisheries, 1996. Fisheries Statistics. Department in Fisheries, Ministry of Agriculture and Cooperatives, Bangkok, Thailand.
- Ferdouse, F., 1994. Overview of Intra-and Extra ASEAN Trade in Fish and Fishery Products. Paper presented at Conference on Fisheries Management and Development Strategies for the ASEAN Region for the Year 2000.
- Fish Inspection and Quality Control Division, 1993. Fish Inspection Annual Report. Department of Fisheries, Thailand. 158 p.
- Fish Technological Development Institute, 1995. FTDI Technical Abstracts. Technical papers: 1984-1994. Department of Fisheries. Thailand. 30 p.
- Suwanrangi, S. 1996. HACCP Application in Thailand. Paper presented at the International Conference on Fish Inspection and Quality Control. Double Tree Hotel, Virginia, USA. 19 -24 May 1996.
- Suwanrangi, S. 1996. Training on HACCP in Thailand. Paper presented at the International Conference on Fish Inspection and Quality Control. Double Tree Hotel, Virginia, USA. 19 -24 May 1996.
- Thai Food Processors Association. 1996. The 25th Anniversary, 1995. Thai Food Processors Association, Ocean Tower Building, Klong Toey, Bangkok, Thailand. 122 p.
- Thai Frozen Foods Association. 1995. The Thai Frozen Food Association. ITF Building Silom, Bangkok, Thailand. 156 p.
- Tookvinas, S. and Suwanrangi, S. 1996. Hazard Control in Aquaculture. Paper presented at the International Conference on Fish Inspection and Quality Control. Double Tree Hotel, Virginia, USA. 19 -24 May 1996.



The Seminar was informed that in relation to quality inspection of aquaculture shrimps in Thailand, 22 stations all over Thailand have been equipped with High Performance Liquid Chromatographs (HPLCs).

Table 1. Fisheries production in quantity by sub-sector (1983-1993).

Year	Total	Unit : 1,000 tonnes			
		Capture		Aquaculture	
		Marine	Inland	Coastal	Freshwater
1983	2,255.40	2055.20	108.40	44.80	47.00
1984	2,134.80	1911.50	111.40	61.50	50.40
1985	2,225.20	1997.20	92.20	60.60	75.20
1986	2,536.30	2309.50	98.40	39.10	89.30
1987	2,779.10	2540.00	87.40	61.90	89.80
1988	2,629.70	2337.20	81.50	108.90	102.10
1989	2,740.00	2370.50	109.10	168.70	91.70
1990	2,786.40	2362.20	127.20	193.20	103.80
1991	2,967.70	2478.60	136.00	230.40	122.70
1992	3,239.80	2736.40	132.00	229.30	142.10
1993	3,385.10	2752.50	175.40	295.60	161.60

Source : Department of Fisheries, 1996.

Table 2. Production of shrimp by sub-sectors (1989-1995)

Year	Total	Quantity : Tonnes			
		Capture		Culture	
		Sub-total	%	Sub-total	%
1989	178,699	85,204	47.68	93,495	52.32
1990	201,239	83,012	41.25	118,227	58.75
1991	268,565	106,495	39.65	162,070	60.35
1992	276,500	91,616	33.13	184,884	66.87
1993	321,085	95,571	29.77	225,514	70.23
1994	363,446	100,000	27.51	263,446	72.49
1995	385,000	105,000	27.27	280,000	72.73

Source : Department of Fisheries, 1996.

Table 3. Fisheries production in value by sub-sectors (1983-1993).

Year	Total	Value : Million US\$			
		Capture		Aquaculture	
		Marine	Inland	Coastal	Freshwater
1983	769.53	561.96	119.86	47.48	40.22
1984	733.48	531.09	102.78	50.56	49.06
1985	791.42	563.09	102.79	62.93	62.61
1986	915.29	679.49	82.80	75.60	77.40
1987	1,105.66	774.28	84.52	149.04	97.81
1988	1,296.90	792.92	71.39	328.68	103.92
1989	1,434.80	797.41	89.13	459.74	88.52
1990	1,655.83	829.54	132.07	618.94	104.08
1991	2,121.03	1,056.15	83.63	814.48	118.77
1992	2,621.78	1,313.32	119.95	1,049.38	139.13
1993	3,136.27	1,448.96	179.58	1,344.14	163.58

Source : Department of Fisheries, 1996

Table 4. Total catch by species group (1983 - 1993).

Unit : 1,000 Tonnes

Year	Total	Marine Fisheries							Freshwater Fisheries			
		Sub- total	Fish	Shrimp	Crabs	Squid & Cuttlefish	Molluscs	Others	Sub-total	Fish	Shrimps	Others
1983	2,255.40	2,100.00	1,481.80	161.00	28.60	132.00	115.60	181.00	155.40	144.00	5.90	5.50
1984	2,134.80	1,973.00	1,514.10	137.30	27.00	129.30	153.60	11.70	161.80	150.20	7.40	4.20
1985	2,225.20	2,057.70	1,570.40	127.70	26.80	116.00	183.50	33.30	167.50	152.40	10.30	4.80
1986	2,540.00	2,352.20	1,798.90	141.20	35.60	134.90	164.30	77.30	187.80	175.30	8.50	4.00
1987	2,779.00	2,601.90	2,017.40	151.60	40.40	132.50	217.80	42.20	177.10	158.60	15.00	3.50
1988	2,629.70	2,446.10	1,867.70	165.90	41.90	124.20	227.20	19.20	183.60	167.10	14.40	2.10
1989	2,740.00	2,539.20	1,932.50	204.30	42.30	142.90	200.60	16.60	200.80	192.80	8.00	0.00
1990	2,786.40	2,555.40	1,948.10	225.70	41.60	135.10	190.90	14.00	231.00	224.40	6.60	0.00
1991	2,967.70	2,709.00	2,020.20	291.20	45.20	154.40	142.60	55.40	258.70	250.80	7.90	0.00
1992	3,239.80	2,965.70	2,230.70	301.60	44.50	150.30	135.40	103.20	274.10	263.50	10.40	0.20
1993	3,385.10	3,048.10	2,353.60	344.40	47.10	153.30	134.10	15.60	337.00	327.20	9.30	0.50
%Growth from 1989	23.50	20.00	21.80	68.60	11.30	7.30	-33.20	-6.00	67.83	69.71	16.25	23.81*

Source: Department of Fisheries ,1996.

* % Growth from 1988

Table 5. Disposition of marine catch by types of fish processing (1989-1993).

Type of plant	Quantity: tonnes				
	1989	1990	1991	1992	1993
Freezing	460,277	548,614	527,925	800,118	833,853
Canning	684,614	761,391	775,808	923,362	899,952
Fish sauce	31,467	35,989	37,550	34,762	38,671
Budu sauce	347	356	369	352	346
Steaming	4,219	3,808	4,297	4,707	4,721
Smoking	3,674	3,150	3,194	1,904	1,745
Salted fish	63,175	65,216	60,541	53,163	52,283
Dried fish	31,083	27,765	26,716	37,723	32,491
Dried squid	34,728	33,955	34,505	35,184	34,688
Dried shellfish	2,669	2,947	2,938	3,024	2,429
Fish ball	6,192	5,962	5,998	6,009	5,888
Fish cracker	832	606	948	1,919	1,414
Fish meal	1,071,025	1,087,026	1,115,298	1,389,521	1,374,683
Total	2,394,302	2,576,785	2,596,087	3,291,748	3,283,164

Source : Department of Fisheries, 1996.

Table 6. Number of fish processing establishments ,1983-1993.

Type of plant	1989	1990	1991	1992	1993
Freezing	94	108	100	120	129
Canning	43	42	42	49	52
Fish meal	118	116	110	110	104
Fish sauce	29	29	27	27	81
Budu	65	55	62	71	107
Steaming	38	36	30	28	28
Smoking	830	750	632	621	702
Salted fish	213	205	168	188	192
Dried shrimp	772	712	642	605	604
Dried squid	646	646	523	456	484
Dried shellfish	95	94	86	86	86
Fish ball	95	90	89	92	112
Fish-Shrimp cracker	85	104	102	106	115

Source : Department of Fisheries, 1996

Table 7. Value of Fisheries Trade (1983-1995).

Quantity : tonnes; Value : US\$million

Year	Export			Import		
	Quantity	Value		Quantity	Value	
		US\$	% Change		US\$	% Change
1983	344,899	507,086.92	13.0	58,942	43,723.24	51.0
1984	411,722	603,235.72	19.0	119,064	84,773.52	94.0
1985	466,219	741,106.40	23.0	152,707	154,298.28	82.0
1986	602,486	1,076,174.48	45.0	268,089	303,601.12	97.0
1987	663,650	1,306,173.28	22.0	227,327	280,675.32	(8.0)
1988	799,357	1,778,673.28	36.0	347,676	588,579.76	110.0
1989	876,497	2,150,044.48	21.0	455,762	762,703.84	30.0
1990	912,181	2,453,926.92	14.0	506,540	829,088.40	9.0
1991	1,088,253	3,139,943.60	28.0	724,769	1,094,343.80	32.0
1992	1,106,141	3,298,771.92	5.0	714,012	982,747.52	(10.0)
1993	1,115,079	3,640,733.32	10.0	760,920	865,174.80	(12.0)
1994	1,254,656	4,411,409.08	21.0	893,656	853,156.36	(2.0)
1995	1,192,558	4,663,112.04	5.7	872,830	876,988.40	2.7

Source: Department of Fisheries, 1996.

Table 8. Fisheries Export to Major Desination

Value : US\$ Millon

Country	1989	1990	1991	1992	1993	1994
Japan	790.51	873.99	1,117.41	1,172.11	1,313.03	1,474.10
USA	514.96	646.86	857.58	917.69	1,013.99	1,237.32
EU	378.63	455.65	524.33	505.06	452.33	526.60
Canada	60.91	2.22	82.93	109.69	143.60	161.15
ASEAN	141.34	110.70	113.68	137.15	142.91	79.02
ANZEC	95.32	88.66	114.52	114.01	126.61	66.70
EFTA	43.91	51.08	56.97	75.19	75.56	37.53
C. Taipei	3.49	7.91	9.21	22.85	74.75	44.45
Other	120.96	164.41	253.31	245.01	297.96	184.82
Total	2,150.04	2,401.48	3,139.94	3,298.77	3,640.73	3,811.68

Source : Department of Fischeires, 1996.

Table 9. Thailand export of fish and fisheries products (1990-1994).

Items	Quantity : metric tonnes; Value : US\$ million									
	1990		1991		1992		1993		1994	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
EXPORT OF FISHERY PRODUCTS	750,170	2,312.08	903,515	2,958.32	940,327	3,127.60	969,147	3,447.68	1,072,353	4,215.04
1. Fish; fresh, chilled, frozen	191,977	181.56	236,896	324.24	291,838	322.40	281,572	327.84	286,383	338.16
Fish; fresh, chilled, frozen (excl. fillets)	140,690	75.68	150,876	74.52	205,603	99.96	195,875	98.88	199,180	120.52
Fish; fillet, fresh, frozen	51,287	105.92	86,020	249.72	86,235	222.44	85,697	228.96	87,203	217.64
Fish; live	1,877	6.28	1,897	6.32	3,190	10.20	3,960	11.36	14,368	12.24
Fish; live for aquarium	52	0.24	51	0.24	83	0.32	112	0.36	172	0.56
2. Cephalopod; fresh, chilled, frozen	62,206	182.52	62,460	220.32	63,405	226.08	58,256	234.48	60,228	282.24
3. Seaweed	135	1.36	99	1.28	98	1.28	95	1.24	102	1.60
4. Ark - shells; fresh, chilled, frozen	5	-	12	-	5	-	19	-	13	-
5. Shrimps; fresh, chilled, frozen	84,724	818.16	121,240	1,067.24	130,516	1,267.84	148,866	1,513.68	199,476	1,966.24
6. Agar - agar	1	-	2	0.04	5	0.08	8	0.16	9	0.16
7. Crabs, crab meat; fresh, chilled, frozen	290	0.84	380	1.52	1,036	4.60	1,113	4.44	2,005	7.08
8. Fish; dried salted or in brine, smoked	20,497	19.24	22,515	25.92	19,349	26.00	18,916	35.96	15,842	21.96
9. Cephalopod; brine, dried	3,938	41.48	2,765	32.64	3,402	42.40	2,430	35.16	1,442	19.92
10. Shrimps; salted in brine or dried	1,610	9.44	1,816	12.76	1,703	11.88	1,649	12.40	1,430	11.56
11. Shrimps; simply boiled in water	993	7.04	931	9.40	546	5.92	1,673	18.72	1,515	16.04
12. Sharks fins ; brine dried	25	1.24	28	0.84	18	6.40	22	0.84	35	1.68
13. Jelly fish; salted, brine of dried	6,412	4.28	11,938	10.80	6,543	6.76	2,559	3.48	7,439	7.28
14. Crustaceans and molluscs; salted or dried	3,673	14.16	4,578	19.08	4,258	15.60	4,651	17.56	4,910	20.48
15. Other crustaceans; fresh chilled or frozen	813	6.36	846	8.28	1,302	13.36	1,343	7.80	1,481	8.28
16. Shell	*	-	3	-	*	-	9	-	1	-
17. Other products of crustaceans	951	2.20	884	3.04	371	2.60	580	2.88	647	3.08
18. Fish roes and other fish parts, frozen	23	0.04	110	1.40	81	0.52	12	-	4	-
19. Prepared or preserved fish	28,779	57.40	36,454	73.60	40,893	81.76	104,274	102.84	60,681	126.32
20. Cephalopod; prepared	4,817	11.44	4,471	12.40	2,469	6.72	1,135	3.12	396	1.56
21. Cephalopod; prepared	4,328	25.20	4,025	23.44	2,693	16.48	3,019	18.48	2,306	14.60
22. <i>Blanchan</i> not in airtight containers	3,207	7.72	2,669	6.28	3,035	8.84	2,968	11.28	2,211	8.16
23. Other crustaceans and molluscs prepared or preserved	85	0.40	2,105	11.44	3,566	18.84	2,420	13.40	5,428	28.08
24. Sardines; prepared or preserved	19,696	23.92	28,333	35.64	25,996	32.64	33,734	42.12	48,735	41.48
25. Tuna; prepared or preserved	258,401	625.56	305,277	736.64	279,070	622.04	258,484	597.12	291,854	689.80
26. <i>Asari</i> prepared in airtight containers	9,674	15.60	4,386	8.20	5,013	12.60	3,426	8.28	5,214	12.80
27. <i>Asari</i> prepared not in airtight containers	1,875	4.24	913	2.60	799	2.64	391	1.48	452	1.88
28. Crab; prepared or preserved	10,001	52.52	9,827	47.04	9,713	53.48	8,778	46.04	6,903	39.68
29. Shrimp; prepared or preserved	29,110	191.64	35,604	225.72	39,331	313.16	42,653	375.16	50,671	532.08

Source : Center for agriculture statistics, 1996.

Table 10. Thailand Import of Fish and Fisheries Products (1990-1994).

Items	Quantity : metric tonnes;						Value : US\$million			
	1990		1991		1992		1993		1994	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
IMPORT OF FISHERY PRODUCTS	752,358	807.16	670,545	1,054.20	645,289	930.80	616,844	769.92	683,681	727.44
1. Fish; fresh, chilled, frozen	698,621	753.68	596,539	973.28	563,403	820.92	539,040	645.72	568,692	555.16
Fish; fresh, chilled, frozen (excl. fillets)	696,379	751.20	593,800	970.68	561,267	819.00	535,091	642.88	567,401	553.48
Fish; fillets, fresh, frozen	2,243	2.48	2,739	2.64	2,136	1.96	3,949	2.84	1,295	1.68
2. Fish; live	11	0.16	12	0.32	13	0.24	12	0.20	41	0.08
3. Fish; live for aquarium	7	0.32	7	0.24	8	0.36	7	0.32	12	0.48
4. Cephalopod; fresh, chilled, frozen	2,462	1.80	5,639	8.72	10,281	13.76	14,018	22.84	36,901	59.48
5. Shrimps; fresh, chilled, frozen	1,363	7.00	6,010	13.96	3,495	17.48	4,824	28.68	7,367	34.12
6. Fish; salted, in brine, dried	297	0.20	19	0.20	506	0.64	1,261	0.60	2,520	1.40
7. Cephalopod; brine, dried	1,374	4.96	2,924	6.48	3,364	6.52	5,706	13.08	1,538	5.16
8. Sharks fins; brine, dried	67	0.80	19	0.28	60	0.68	100	1.44	127	1.60
9. Beche-demer; brine, dried	6	-	3	0.02	10	0.04	11	0.40	15	0.04
10. Ark-shells; fresh, chilled, frozen	32,285	4.92	36,721	5.48	41,846	6.72	35,185	5.64	39,744	6.12
11. Seaweed	90	1.04	106	1.48	151	2.84	213	4.16	305	7.96
12. Agar-agar	347	7.96	326	7.60	435	9.32	472	9.04	594	10.56
13. Other crustaceans; fresh, chilled, frozen	854	2.80	1,138	6.96	3,567	19.32	2,181	9.92	2,471	9.32
14. Fish and crustaceans preparation	8,986	9.24	12,720	6.92	9,489	9.48	6,902	9.04	12,374	13.44
15. Fish roes and other fish parts frozen	2	-	1,884	8.20	483	7.84	325	6.04	249	3.52
16. Other products of crustaceans	954	8.88	1,042	11.00	4,107	12.04	2,031	9.80	4,143	14.12
17. Fish liver oils	793	0.84	127	0.16	216	0.20	419	0.36	981	0.76
18. Fats and oils of marine mammals	3,839	0.84	5,309	2.88	3,853	2.36	4,130	3.00	5,801	4.00
19. Spermaceti	-	-	-	-	2	0.01	7	0.02	2	0.01

Source : Center for agriculture statistics, 1996.

Table 11. Export of major fishery products commodities (1992 -1996).

Target items	Quantity : metric tonnes;				Value : US\$ million					
	1992		1993		1994		1995		1996*	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
1. Shrimp	132,761.0	1,286.1	152,220.0	1,544.9	176,735.0	1,993.9	183,200.0	2,034.0	203,900.0	2,242.0
1.1 Frozen shrimp	130,631.0	1,268.3	148,901.0	1,513.7	173,881.0	1,966.2	180,000.0	2,000.0	200,000.0	2,200.0
1.2 Dried shrimp	1,072.0	11.9	1,646.0	12.4	1,429.0	11.6	2,000.0	16.0	2,400.0	20.0
1.3 Frozen cooked shrimp	58.0	5.9	1,673.0	18.7	1,425.0	16.1	1,200.0	18.0	1,500.0	22.0
2. Cephalopods	69,495.0	284.9	63,708.0	288.1	64,117.0	317.1	66,600.0	362.0	68,100.0	376.4
2.1 Frozen cephalopods	63,404.0	226.1	58,258.0	234.5	60,229.0	282.3	62,000.0	320.0	62,000.0	328.0
2.2 Dried cephalopods	3,401.0	42.4	2,430.0	35.2	1,584.0	20.2	1,400.0	18.4	1,600.0	21.2
2.3 Processed cephalopods	2,609.0	16.5	3,020.0	18.5	2,304.0	14.6	3,200.0	24.0	4,000.0	27.2
3. Fish	314,721.0	353.5	304,264.0	360.4	306,931.0	372.3	320,000.0	391.2	311,000.0	398.0
3.1 Fillet/minced fish	86,251.0	222.5	85,697.0	229.0	82,203.0	217.6	90,000.0	232.0	90,000.0	240.0
3.2 Frozen whole fish	206,238.0	101.0	196,014.0	99.0	199,448.0	120.8	210,000.0	124.0	200,000.0	120.0
3.3 Dried fish	18,958.0	19.5	18,481.0	20.6	15,763.0	21.1	15,000.0	20.0	15,000.0	20.0
3.4 Live fish and fish fries	3,274.0	10.5	4,072.0	11.8	4,517.0	12.8	5,000.0	15.2	6,000.0	18.0
4. Seafood : canned / processed	409,524.0	1,152.4	408,859.0	1,201.4	442,720.0	1,483.3	461,650.0	1,586.0	482,000.0	1,728.0
4.1 Canned seafood	342,094.0	977.0	341,839.0	1,026.4	371,931.0	1,279.8	380,650.0	1,354.0	402,000.0	1,488.0
4.1.1 Canned tuna	243,591.0	537.5	229,901.0	522.5	253,985.0	624.8	250,000.0	624.0	255,000.0	640.0
4.1.2 Canned sardine	25,857.0	32.0	33,392.0	40.9	33,197.0	41.3	35,000.0	44.0	40,000.0	50.0
4.1.3 Canned fish (others)	16,135.0	21.7	22,561.0	30.4	21,572.0	27.6	24,000.0	32.0	25,000.0	34.0
4.1.4 Other canned seafood*	56,511.0	385.8	55,985.0	432.6	5,612.0	14.4	4,150.0	10.0	4,000.0	10.0
4.2 Processed seafood	67,430.0	175.4	67,020.0	175.0	70,789.0	203.5	81,000.0	232.0	80,000.0	240.0
4.2.1 Seafood products	31,949.0	90.9	33,440.0	100.4	47,909.0	138.5	60,000.0	172.0	60,000.0	180.0
4.2.2 Tuna products	35,481.0	84.5	28,580.0	74.6	22,880.0	65.0	21,000.0	60.0	20,000.0	60.0
5. Pet food from fish	153,543.0	123.9	155,158.0	189.2	158,275.0	182.1	168,000.0	203.2	135,000.0	211.2
5.1 Canned pet food	141,847.0	158.4	149,681.0	172.3	135,731.0	172.7	144,000.0	183.2	149,000.0	189.6
5.2 Others	11,696.0	15.5	15,477.0	16.8	22,544.0	19.4	24,000.0	20.0	26,000.0	21.6
6. Fish sauce	30,962.0	37.6	33,492.0	42.5	41,307.0	50.3	50,000.0	60.0	55,000.0	68.0

Source : Department of Business Economic, 1996.

* 1996 : Target Figure

Table 12. Number of frozen products processor by type of products.

Type of processor	Number
Raw shrimp	87
Value added shrimp	11
Cooked shrimp	40
Fish fillet	33
Immitation crab meat	7
Surimi	12
Cephalopod	45
Value added seafood	12

Source : The Frozen Product Associates, 1995.

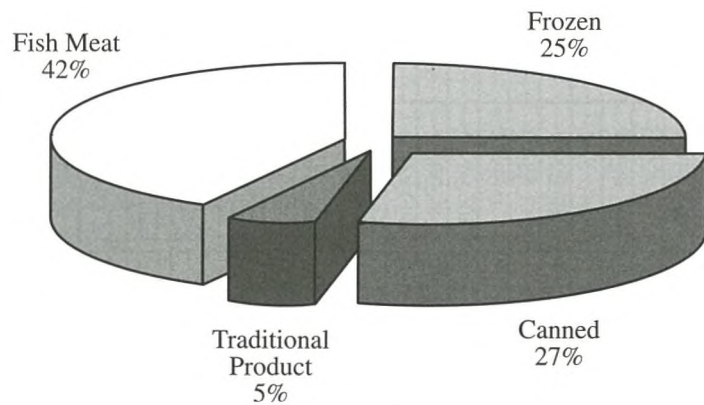


Fig. 1. Utilization of catch for major products for 1993.

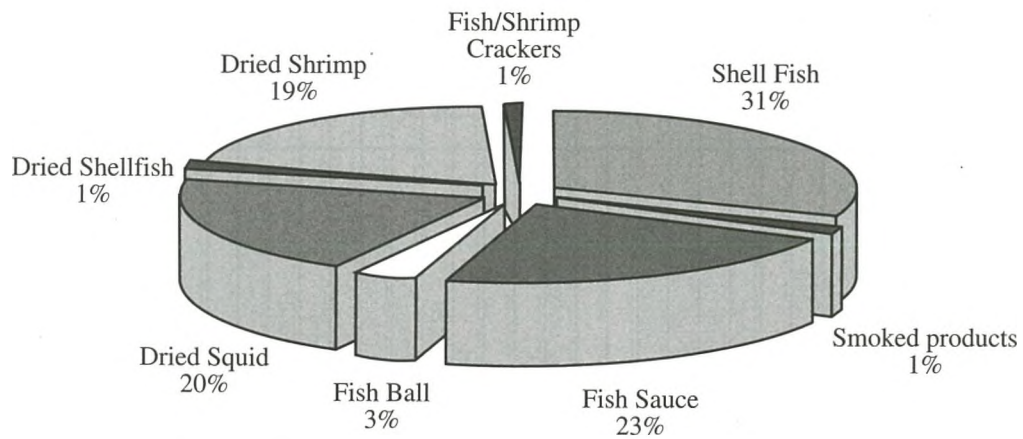


Fig. 2. Utilization of catch for traditional products for 1993.

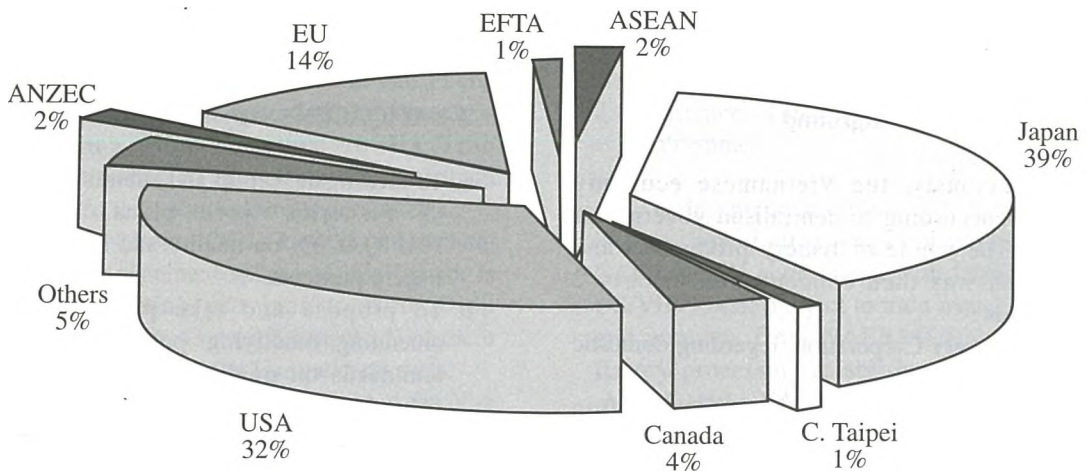


Fig. 3. Fish exports to major destinations in 1994.

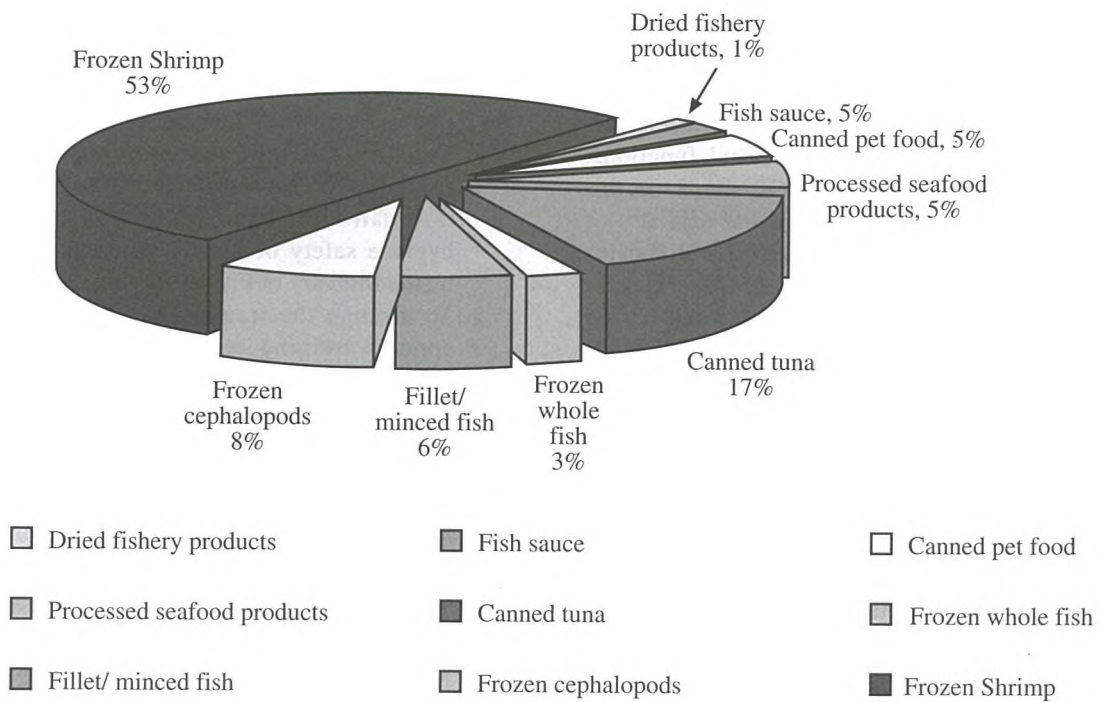


Fig. 4. Thailand's export of major fishery product commodities for 1995.