

# Ensuring Quality and Safety of Fish and Fisheries Products through Improved Post-harvest Technologies and Safety Management Systems

*Yeap Soon Eong and Melvin Chow Wing Chung*

Improving post-harvest technologies and safety management systems has been the focus of the activities of SEAFDEC Marine Fisheries Research Department (MFRD) to ensure quality and safety of fish and fisheries products for food security in the Southeast Asian region. The activities are being undertaken in conjunction with Singapore, which is the Lead Country for the Key Cluster on Post-harvest and Safety of Fish and Fishery Products under the ASEAN Consultative Fisheries Forum (AFCF) Work Plan (2010-2012). Moreover, the activities are aimed at fulfilling the mission of MFRD which is to promote the development of fisheries post-harvest technology in Southeast Asia through research and development and transfer of technology to the fish processing industry in the region.

Post-harvest and Safety of Fish and Fisheries Products encompasses all aspects of fisheries post-harvest technology from handling at sea and on-shore, processing, marketing, until the distribution of fish and fishery products. This also includes the safety and quality aspects of fish products from the waters to tables incorporating both governmental and industrial safety control and regulatory systems. Guided by the Resolution and Plan of Action that was adopted in 2001, MFRD in collaboration with the Agri-Food & Veterinary Authority (AVA) of Singapore through its Post-Harvest Technology Centre supported the ASEAN countries in their efforts towards developing technologies that would optimize the utilization of catch and reduce post-harvest losses, improve quality of traditional fish products, and institute measures to comply with international food safety requirements. With major funding coming from the Japanese Trust Fund through SEAFDEC, the assistance provided by MFRD comes in the form of institution building, human resources development, technology transfer, and standardization of fishery post-harvest procedures and analytical methodologies for both the government and the private sector in the region.

For the sustainable development of fisheries for food security in the Southeast Asian region, post-harvest technology is vital as it could place or displace the region's fish and fisheries products in the world market, and could largely impact the region's economies. It should be considered that in 2007, the Southeast Asian region contributed about 18% or 7,369,862 mt (total world export

of fish and fishery products in 2007 was about 42,172,000 mt (FAO, 2010)) to the international export trade of fish and fishery products, which was valued at 14,395,040 million US Dollars (SEAFDEC, 2010). Moreover, the sustainable development of fisheries post-harvest technology could also lead to the increased availability of quality and safe fish and fisheries products for human consumption by the peoples of the region (Goh and Yeap, 2007).

In a related development, during the Second Meeting of the ASEAN Fisheries Consultative Forum (AFCF) in Brunei Darussalam in June 2010, the AFCF Work Plan for 2010-2012 was endorsed. The Work Plan described the clusters of priority fisheries management activities with the corresponding ASEAN lead countries, and with SEAFDEC as the key partner in many aspects of the implementation of the activities. Specifically, Singapore was identified as the Lead Country for the cluster on Fisheries Post-harvest and Safety of Fish and Fish Products with the main objective of establishing value-addition strategies to key fish products from both capture fisheries and aquaculture in order to make the ASEAN fish and fishery products competitive in the world market. As planned, this cluster is also expected to develop the guidelines on the monitoring system for chemicals, biological medicines and anti-biotic contaminants in fish and fishery products for eventual adoption in the region. Thus, with the Post-Harvest Technology Centre of AVA as the Collaborating Center of SEAFDEC for MFRD programmes, activities have been conducted to promote the safety of fish and fisheries products through improved fisheries post-harvest technologies.



Training on fish processing conducted at MFRD in Singapore

The achievements of MFRD in fisheries post-harvest technology led to the improvement of the fish processing industry in Southeast Asia, and contributed in many ways, to the sustainability of fisheries in the region. This had been achieved through maximizing the utilization of fish catch and reduction of post-harvest losses; improving the quality of traditional fish products through the promotion of quality assurance programs; and upgrading of the regional fish processing industry which were coupled with intensified technology transfer and information dissemination.

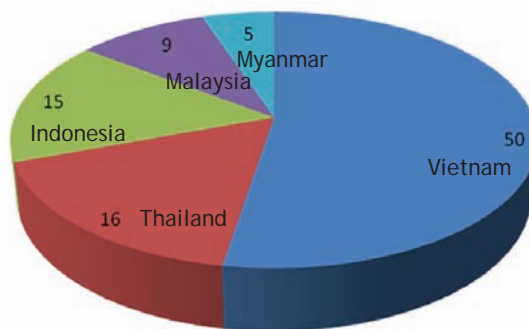
## Maximizing Utilization of Catch and Reduction of Post-harvest Losses

It is of utmost importance that fish catch is responsibly utilized and post-harvest losses are minimized in order to attain food security for the fish-eating peoples in the Southeast Asian region. Thus, for the sustainable development of fisheries post-harvest technology in the region, Goh and Yeap (2007) suggested that it is necessary to maximize the utilization of fish catch and at the same time reduce post-harvest losses while ensuring the safety and quality of the products. Towards this goal, MFRD conducted activities that include the utilization of under-utilized marine and freshwater fish species for the development of surimi and value-added fish products.

In early 1970s, MFRD had introduced for the first time, the surimi processing technology to the region, using tropical fish species such as threadfin bream, croaker, and big-eye snapper, among others. The development of surimi production which included double-step heating to increase the gel strength and shorten setting time resulted in the production of a wide range of surimi products such as chikuwa, fish balls, fish cakes, shrimp balls and imitation crabsticks.

The introduction of the surimi technology by MFRD has considerably led to the development of the surimi industry in Southeast Asia. While surimi technology was unknown in the region in the 70s, through the activities of MFRD, 20 factories were established in the 90s which increased to 32 in 2003, and eventually increasing to 60 in 2006 and to 95 in 2010. Moreover, in 2009 almost 200,000 tons of surimi was produced in the region accounting for about 30% of the world's total surimi production.

Moreover, it should be noted that the development of the surimi industry in the region had offered market for what was considered before as low-value fishes (Siriraksophon *et al.*, 2009). Considering that fish species such as the threadfin bream (*Nemipterus* spp.), lizard fish (*Saurida* spp.), big-eye snapper (*Priacanthus* spp.), croaker (*Johnius* spp.), goatfish or red mullet (*Upeneus*



Number of Surimi factories in Southeast Asia (2010)

spp., *Parapeneus* spp.) used to produce surimi, are economically important for the ASEAN countries, a project on information collection of these species in the Southeast Asian region in terms of fishery resources and their use as raw materials in the surimi industry was conducted by MFRD. The results showed that small fishes could be used to produce frozen surimi considering that these species are often regarded as low economic value due to its poor consumer preference and poor quality because of improper handling onboard fishing vessels (Goh and Tan, 2008).

Thus, using these low-value fish species a wide range of value-added products had been developed for human consumption such as fish sausage, fish loaf, fish burger, fish tofu, fish bah kwa, fish floss, fish cracker, fish siew mai, fish muffin, among others (SEAFDEC/MFRD, 2003 and 2006).

Moreover, MFRD also explored the possibility of turning the waste and trimmings from the fish processing industry into fish products. One of the activities was on the use of by-products of tuna and swordfish processing as raw materials. With Indonesia as the pilot country, the activity was conducted at the National Center for Fish Quality Control and Processing Technology Development (NCQC) in Jakarta, where breaded and battered products as well as fish sausage from the tuna and swordfish trimmings were produced.

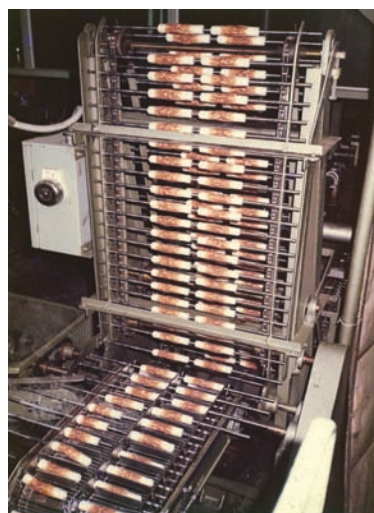




In addition, tuna pico was developed from tuna and marlin meat trimmings. All final fish products were found to have acceptable flavor and texture (SEAFDEC/MFRD, 2003). Moreover, retort pouch technology was also developed and introduced for the production of tuna in mayonnaise, seafood in sweet and sour sauce, and retort pouch for squid.

For the utilization of under-utilized freshwater fish species, Cambodia served as the pilot country for the development of value-added products using common freshwater fish species such as the featherback (*Notopterus* spp.), snakehead (*Channa micropeltes*), moonlight gourami (*Trichogaster microlepis*), and soldier river barb (*Cyclocheilichthys enoplos*). The minced meat of featherback fish and snakehead fish trimmings were also used as raw materials for the development of fish siew mai, fish tofu, fish crackers and fish bah kwa (a sweetmeat), while the soldier river barb was used to produce value-added products such as fish murukku and fish satay (SEAFDEC/MFRD, 2005a).

Moreover, pilot studies on the use of pelagic species such as mackerels (*Rastrelliger kanagurta* and *R. brachysoma*) and round scads (*Decapterus maruadsi*, *D. macrosoma* and *D. russelli*) for processing into fisheries products was conducted in Thailand, Malaysia and Philippines, after which the Standard Operating Procedures for the maximum utilization of pelagic fish resources had been established (SEAFDEC/MFRD, 2006). Specifically, the development of fish sauce using the round scad (*Decapterus russelli* and *D. macrosoma*) and Indian mackerel (*Rastrelliger kanagurta*) using the enzyme protease and “koji” starter



Production of fish chikuwa

culture was carried out, while *R. kanagurta* was also used for the production of fish sausage and ready-to-eat (RTE) braised fish.

In the Philippines, the pilot project was implemented by the Post-harvest Technology Division of the Bureau of Fisheries and Aquatic Resources (PHTD-BFAR), where surimi was processed from *D. maruadsi*, which was then used to produce fish “tapa” and fish cube. Two other products such as fish “kikiam” and fish sausage were developed from *D. macrosoma*. The pilot project activities in Thailand were implemented by the Fishery Technological Development Division of the Department of Fisheries of Thailand (FTDD-DOF).

Two snack products, such as the seasoned dried minced fish sheet and semi-dried fish stick, were developed from *D. maruadsi*, *Rastrelliger brachysoma* and *R. kanagurta*. In order to promote the production of RTEs and other fish products from various fish species in the ASEAN region, MFRD conducted Regional Training Courses in Fish Processing and Packaging (Pelagic Fish) and Technical Consultations in Singapore which had been attended by participants from the ASEAN countries. Processing methods and shelf-life were established for 20 value-added products developed through the pilot projects utilizing the target pelagic fish species. Specifically, the manual which was an outcome of the pilot activities included the processing methods for fish sausage from MFRD, fish crackers from Malaysia, seasoned dried minced fish sheet (pla pan) from Thailand, and fish *kikiam* from the Philippines.

Moreover, an activity which aimed to improve the processing of fish sauce was conducted. This was aimed at reducing the fermentation time (SEAFDEC, 2003a) which usually is about one to two years, was conducted using koji (soya bean mash starter culture) and the enzyme takajastse (derived from the fungus *Aspergillus oryzae*).



## Improving the Quality of Traditional Fish Products

A database on the traditional fish products of Southeast Asia had been compiled through a survey of the region's traditional fish products with Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Singapore and Thailand as participating countries. MFRD also assisted the Department of Fisheries of Myanmar in developing HACCP plans for selected traditional fermented fish products in order to upgrade the country's local fish processing industry. As a result, product descriptions, production flow diagrams, hazard analysis and HACCP plans were developed for the following fermented fish products of Myanmar: *nga-pya-ye* (fish sauce), *nga-pi* (whole fish), and *nga-pi* (paste). Assistance was also provided to the Export Quality Control Laboratory (EQCL) of the Department of Fisheries of Myanmar, which is the national laboratory supporting the implementation of the country's HACCP program, to upgrade its laboratory expertise, by training the EQCL officers on the techniques of analyzing histamine (scombroid poisoning) and pesticide contents in fish and fish products.

While carrying out the objective of upgrading the fish processing industry of the Southeast Asian region, MFRD promoted the mechanization of the processes to increase productivity and to work towards automation of the production line. In this regard, equipment that included meat-bone separator, silent cutter, fish ball forming machine, and fish cake forming machine had been modified to suit the capability of the countries in the region but maintaining the performance and efficiency of such equipment.

## Advances in Quality, Safety and Control Systems for Fish Products

MFRD promoted the concept of Hazard Analysis and Critical Control Point (HACCP) in fish processing to the Southeast Asian region in 1990s, and developed the regional capability for the application of HACCP in the fish processing industry (SEAFDEC/MFRD, 2003b). MFRD also continued to promote fish quality and assurance, and preservation by studying the shelf-life of iced and frozen fish and fish products; nutritional composition of fish and fish products; safety of fish and fish products by monitoring heavy metals, antibiotic and pesticide residues; harmonizing the analytical methods through validation and proficiency testing; upgrading the credibility of key regional laboratories through good laboratory practices; and promoting traceability systems for aquaculture products.



Above: Fermenting fish using koji; and  
Left: Fish meat-bone separator

The harmonization of analytical methods through a network of key laboratories in the various ASEAN Member Countries aimed to enhance the status of ASEAN as a coordinated fish-exporting bloc to importing countries, such as Canada, USA, Japan and EU. This has also been envisaged to help facilitate trade in fish and fishery products within and beyond the ASEAN region, by enhancing the capability of the key laboratories in ASEAN through methods validation and inter-laboratory proficiency testing. In order to achieve this goal, a series of training workshops on methods validation was conducted by MFRD for personnel from key laboratories in the region as well as promoting inter-laboratory proficiency testing. MFRD has developed such capability and in 2002, the SAC-SINGLAS Council Committee for Laboratory Accreditation approved the ISO/IEC 17025 accreditation of the MFRD Chemistry Laboratory. The five methods of laboratory testing accredited are for total arsenic, total cadmium, total mercury, total lead and moisture, with all the methods validated.

The concepts of laboratory quality management and implementation of quality management system were included in the training workshops to enable the participants to meet the accreditation requirements and clients needs as well as achieve effective control over their respective laboratories. Factors that could lead to compliance with the requirements of the ISO 17025 accreditation were also included in the training workshops.

The progress made by the lead laboratories had been monitored by MFRD specifically on the progress made by the countries in the preparation of their Laboratory Quality Management Manuals (LQMMs) and implementation of good laboratory practices in their respective lead laboratories. The results of the survey indicated that in 2005, 10 laboratories in seven countries have completed and published their LQMMs, while the other laboratories were still in the various stages of developing their manuals.





Training of staff of regional key laboratories on good laboratory practices

In addition to the preparation of the LQMMs, the lead laboratories also started implementing good laboratory practices, and as a result, 7 laboratories from five ASEAN countries have already implemented good laboratory practices in their laboratories (SEAFDEC/MFRD, 2008).

Moreover, laboratories in four countries have started the measurement of uncertainties for their laboratory methods. In addition, laboratories in 7 ASEAN countries have also completed their methods validation for some methods, although the other laboratories are still in various stages of developing their respective methods of validation. A compilation of validated methods from key regional laboratories was published and circulated to the ASEAN countries. Using the data collected through the survey, the First Regional Inter-laboratory Proficiency Testing for SEAFDEC Key Laboratories, Metallic Contaminants Series, Round 0401 for determination of Arsenic, Cadmium, Lead and Mercury had been initiated by MFRD. Each participating laboratory received an individually numbered Dogfish Liver Material, to be analyzed for Total Arsenic, Total Lead, Total Mercury and Total Cadmium. Meanwhile, MFRD continued to take part in the Inter-Laboratory Proficiency Testing under the Food Analysis Performance Assessment Scheme (FAPAS) for the determination of total mercury, arsenic, cadmium, lead, moisture, ash, total fat and nitrogen.

A series of Regional Workshops on the Application of HACCP in the Fish Processing Industry in Southeast Asia were conducted to assess the application of HACCP in the fish processing industry in the region and provide a regional platform for sharing of information and knowledge on HACCP application among the ASEAN Member Countries (SEAFDEC/MFRD, 2003b). Moreover, a fish and fish products safety information network was established which comprises experts and institutions specializing in seafood safety in the region. In this connection, the website (<http://www.fishsafetynfo.com>) was launched while country

coordinators were designated and as agreed, information on issues relevant to seafood safety in the region had been shared. The Regionalization of the Code of Conduct for Responsible Fisheries (RCCRF) Phase IV: Post-harvest Practices and Trade was also undertaken as a means of identifying and addressing the issues related to post-harvest practices as well as clarifying the applicability of the global CCRF on post-harvest practices in the context of the Southeast Asian region. The Regional Guidelines for Responsible Fisheries: Responsible Post-harvest Practices and Trade was published in April 2005 (SEAFDEC, 2005).

While it has been recognized that many small and medium size fish and processing establishments (SMEs) in the ASEAN countries have difficulty in implementing quality management systems due to economic and technical constraints, MFRD carried out an activity to address this concern. These SMEs largely comprise the Pre-Processing Establishments (PPEs), which produce semi-processed raw materials for main processing establishments and the Traditional Fish Products Processing Establishments (TPEs). The ASEAN countries have identified that this sector of the industry requires assistance to upgrade their quality management programs, beginning with the basic GMP and SSOP (SEAFDEC/MFRD, 2008a and

Box 1. Development of GMP/SSOP programs for Pre-Processing Establishments (PPEs)

Country	Types of PPE
Cambodia	Crab meat (picking)
Indonesia	Fish meat/fillet (for surimi)
Malaysia	Shrimp pre-processing Fish meat/fillet (for surimi/otoshimi)
Myanmar	Shrimp pre-processing
Philippines	Shrimp salting (for shrimp paste) Crab meat (picking)
Thailand	Shrimp pre-processing
Vietnam	Shrimp pre-processing

Box 2. Development of GMP/SSOP programs for Traditional Fish Products Processing Establishments (TPEs)

Country	Types of TPE
Brunei Darussalam	Fermented shrimp paste ( <i>belacan</i> )
Indonesia	Salted boiled fish ( <i>pindang</i> )
Lao PDR	Dried fish ( <i>pa heang</i> )
Malaysia	Fermented cracker ( <i>keropok lekor</i> )
Myanmar	Fermented (pickled) fish ( <i>ngachim</i> ) Fish sauce ( <i>ngan pya ye</i> )
Philippines	Smoked milkfish ( <i>tinapa</i> ) Shrimp sauce ( <i>alamang</i> )
Singapore	Fish balls/fish cakes
Thailand	Fish sauce ( <i>nam pla</i> ) Dried shrimp
Vietnam	Fish sauce ( <i>nuoc mam</i> ) Fermented tiny shrimp paste ( <i>mam tom</i> )

2010). Moreover, the development of the GMP/SSOP programmes for the PPEs and TPEs (**Box 1** and **Box 2**) had also been envisaged to enable the ASEAN countries to achieve *Measure No. 46* of the ASEAN Roadmap for the Integration of the Fisheries Sector under the ASEAN Framework Agreement for the Integration of Priority Sectors. Specifically, *Measure No 46*: prescribed the need to develop and apply fisheries quality management system that could ensure food safety and support the competitive position of ASEAN fisheries products in the world markets through implementation, validation, verification of Hazard Analysis Critical Control Point (HACCP)-based systems and improved laboratories practices, and adapting quality and safety management systems for possible application by the small enterprises in ASEAN.

Chemical residues in fish and fisheries products in Southeast Asia was also investigated by MFRD where the methodologies on biotoxins analyses were developed through human resource training for understanding the levels of biotoxin occurrences and incidences in fish and fisheries products in the countries in the region. In this regard, Regional Technical Consultation on Biotoxins Monitoring in ASEAN and the Regional Training Course in Biotoxins Analysis were conducted in 2009 and 2010, respectively. In addition, the Research and Analysis of Chemical Residues and Chemical Contamination in Fish and Fish Products and in Environment such as Fishing Ground and Aquaculture Field were also undertaken to obtain an understanding the levels of chemical contaminants in fish and fish products in Southeast Asia.

A regional survey on heavy metals (arsenic, cadmium, lead and total mercury) in fish and fish products was conducted in the ASEAN countries, through the participating regional laboratories in Cambodia, Indonesia, Malaysia, Myanmar, Singapore, Thailand, and Vietnam (SEAFDEC/MFRD 2008b). Fish and fish products that are of economical and social importance to the participating countries were targeted, and results of the survey were deposited in the database of the Fish and Fish Products Safety Information Network. In addition, to ensure the accuracy and comparability of the different methods used by Member Countries, Inter-laboratory Proficiency Testing for the test methods was conducted by MFRD and in the process, MFRD also assisted in the upgrading of regional laboratory personnel skills in conducting heavy metals analysis using Atomic Absorption Spectrometry (AAS) through a series of on-site training at project sites in Indonesia, Myanmar and Vietnam.

Upgrading the capability of staff from the regional laboratories was also carried out to enable them to conduct pesticide residues analysis using Gas Chromatography

Mass Spectrometry (GC-MS) and facilitate the implementation of the regional surveys on the pesticide residues (organochlorines) in fish and fish products in the SEAFDEC Member Countries (SEAFDEC/MFRD, 2004). The results of the survey were deposited in the database of the Fish and Fish Products Safety Information Network. In addition, the survey of Histamine Levels in Fish and Fish Products in Southeast Asia was conducted especially for the naturally occurring toxin, histamine, in fish and fish products. As agreed during the Mid-term Review Meeting in 2007, although the analysis of fermented fish and fish products such as shrimp paste and fish sauce was included in the survey, the countries were given the option to decide on the type of fermented fish and fish products to be surveyed considering the financial resources of the countries. Moreover, with the assistance of the Department of Fisheries (DOF) of Thailand, on-site training courses for histamine analysis using fluorometric and High Performance Liquid Chromatography (HPLC) method were conducted in order to upgrade the technical capability in histamine testing in the region.

Training on the analysis of antibiotics especially in the detection of prohibited drugs such as chloramphenicol and nitrofurantoin used in aquaculture farms was also conducted (SEAFDEC/MFRD, 2005). The Vietnam National Agriculture, Forestry and Fisheries Quality Assurance Department (NAFIQAD) and MFRD co-organized the training for three methods, namely: Chloramphenicol, Nitrofurantoin and Malachite Green using Liquid Chromatography Mass Spectrometry (LC-MS-MS) method. Regional surveys of chloramphenicol, nitrofurantoin, malachite green and leuco-malachite green in fish and fish products were then conducted by the participating regional laboratories in Indonesia, Malaysia, Myanmar, Philippines, Thailand and Vietnam. Nevertheless, in view of the different analytical methods used in the survey, the participating countries took part in the inter-laboratory proficiency testing under FAPAS Round 02109 for chloramphenicol in shrimp sample. The results of the activities were deposited in the database of the Fish and Fish Products Safety Information Network.

## Traceability Systems for Aquaculture Products in the ASEAN Region

A Consultation on the implementation of traceability systems in the ASEAN countries was organized in Singapore in October 2010 where the country participants presented country reports to share their knowledge on food fish traceability systems. The Consultation agreed to conduct the first on-site training for food dish traceability in Vietnam in 2011 and the 2<sup>nd</sup> on-site training for shrimp traceability systems in Thailand in 2013.

## Way Forward

As indicated in its goals, MFRD aims to: establish the Department as a coordinating center for research and development in fisheries post-harvest technology in the region; sustain the Department as the Regional Training Center for the ASEAN and the Third Country Training in Fisheries Post-harvest Technology; and promote the Department as the Regional Information Hub in fisheries post-harvest technology through the ASEAN Fisheries Post-harvest Technology Information Network. In order to attain such objectives, MFRD is committed to driving the regional effort towards sustainable fisheries development in fisheries post-harvest technology by: optimizing the use of limited fisheries resources; developing value-added products from under-utilized fish species; reducing post-harvest losses and wastage; harmonizing analytical procedures and testing capabilities; promoting the implementation of quality assurance programmes and food safety management systems; upgrading the regional fish processing industry especially the small and medium size enterprises; and developing human resources.

## References

- FAO. 2010. FAO Yearbook of Fishery and Aquaculture Statistics 2008. FAO, Rome, Italy
- Goh Kian Heng and Tan-Low Lai Kim. 2008. Maximizing the Utilization of Fish Catch for Human Consumption. *In: Fish for the People Vol. 6, No. 3: 2008*. Southeast Asian Fisheries Development Center, Bangkok, Thailand; pp 27-30
- Goh Kian Heng and Yeap Soon Eong. 2007. Towards Sustainable Post-harvest Technology Development in Southeast Asia. *In: Fish for the People Vol. 5, No. 2: 2007*. Southeast Asian Fisheries Development Center, Bangkok, Thailand; pp 2-7
- SEAFDEC. 2005. Regional Guidelines for Responsible Fisheries in Southeast Asia: Responsible Post-harvest Practices and Trade. Southeast Asian Fisheries Development Center, Bangkok, Thailand; 58 p
- SEAFDEC. 2010. Fishery Statistical Bulletin for the South China Sea Area 2007. Southeast Asian Fisheries Development Center, Bangkok, Thailand, February 2010; 165 p
- SEAFDEC/MFRD. 2003. Maximizing Utilization of Fish Catch – Marine Species (In English and Bahasa Indonesia). SEAFDEC Marine Fisheries Research Department, Singapore; 84p
- SEAFDEC/MFRD. 2003a. Fermented Fish Sauce in Southeast Asia. SEAFDEC Marine Fisheries Research Department, Singapore; 61 p
- SEAFDEC/MFRD. 2003b. The Application of HACCP in the Fish Processing Industry in Southeast Asia 2000-2003. SEAFDEC Marine Fisheries Research Department, Singapore; 150 p
- SEAFDEC/MFRD. 2004. Laboratory Manual of Standardized Methods for the Analysis of Pesticide and Antibiotic Residues in Aquaculture Products. SEAFDEC Marine Fisheries Research Department, Singapore; 46 p
- SEAFDEC/MFRD. 2005. Laboratory Manual of Standardized Methods for the Analysis of Chloramphenicol and Nitrofurans Residues in Aquaculture Products. SEAFDEC Marine Fisheries Research Department, Singapore; 34 p
- SEAFDEC/MFRD. 2005a. Maximizing Utilization of Fish Catch – Freshwater Species. SEAFDEC Marine Fisheries Research Department, Singapore; 42 p
- SEAFDEC/MFRD. 2006. Maximizing Utilization of Pelagic Fish Resources. SEAFDEC Marine Fisheries Research Department, Singapore; 124 p
- SEAFDEC/MFRD. 2007. ASEAN Hazard Guide: A Guide to the Identification and Control of Food Safety Hazards in the Production of Fish and Fish Products in the ASEAN Region. SEAFDEC Marine Fisheries Research Department, Singapore; 185 p
- SEAFDEC/MFRD. 2008. Compilation of Manual of Validated Methods from Key Regional Laboratories. SEAFDEC Marine Fisheries Research Department, Singapore; 164 p
- SEAFDEC/MFRD. 2008a. Good Manufacturing Practice (GMP) for Small and Medium-sized Fish and Fish Products Pre-Processing Establishments in ASEAN. SEAFDEC Marine Fisheries Research Department, Singapore; 62 p
- SEAFDEC/MFRD. 2008b. Technical Compilation on Heavy Metals, Pesticide Residues, Histamine and Drug Residues in Fish and Fish Products in Southeast Asia. SEAFDEC Marine Fisheries Research Department, Singapore; 203 p
- SEAFDEC/MFRD. 2010. Good Manufacturing Practice (GMP) for Small and Medium-sized Traditional Fish Products Processing Establishments in ASEAN. SEAFDEC Marine Fisheries Research Department, Singapore; 130 p
- Siriraksophon, Somboon, Siripon Pangsorn and Penchan Laong-manee. 2009. The Surimi Industry in Southeast Asia: Trend and demand for raw materials. *In: Fish for the People Vol. 7, No. 23: 2009*. Southeast Asian Fisheries Development Center, Bangkok, Thailand; pp 2-8

### About the Authors

Mr. Yeap Soon Eong is the Chief of the SEAFDEC Marine Fisheries Research Department based in Singapore.

Mr. Melvin Chow Wing Chung is the Deputy Director for Planning and Management, Food Supply Resilience Department of the Agri-Food & Veterinary Authority of Singapore, and the SEAFDEC National Coordinator for Singapore.