HACCP in shrimp farming

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The authors conducted a training workshop on the application of HACCP in shrimp farming in Chennai, India on the request of MPEDA and NACA. This article is based on their resource paper.

The Thai shrimp aquaculture industry has had an excellent record in the production of safe products of consistent quality. However, as aquaculture production expands, the industry and regulatory agencies become more concerned with hazards that impact on people's health and safety. Specific problems which may be encountered in shrimp aquaculture products include:

- Contamination by microbial pathogens *e.g.* Salmonella, *Vibrio cholerae.*
- Presence of veterinary drugs (and other substances) that may have hazardous effects on consumers, handlers, and the environment.
- Residues of aquaculture chemicals or other environmental contaminants.

A surveillance program for cultured shrimp can include HACCP at all operations, including the production and handling of raw materials, processing operations, the processing environment, handling and storage practices, and distribution activities. This approach reduces reliance on analytical tests and the need for comprehensive inspection of finished aquaculture products by dealing with a hazard before it impacts on processors and consumers. Hazards in shrimp aquaculture include microbiological and chemical hazards associated with the inappropriate use of drugs and chemicals in aquaculture.

Background

Production from shrimp aquaculture in Thailand has increased from 1.2 million kg in 1986 to 3.3 million kg in 2003 (Fisheries Information Center, 2004). The industry involves 80% small-scale farmers and 20% intensive scale aquaculture. Shrimp has become a major port commodity and its production, processing and marketing a major source of income of people in the industry.

Processing cocktail shrimp. Taken inside the Union Frozen Food Products Public Company in Samut Sakhorn Thailand. The company sources out raw materials from shrimp farms observing good aquaculture practices or CoC in shrimp aquaculture assisted by the Department of Fisheries

Environmental impacts of shrimp have been an increasing concern of government and the public. The impacts include mangrove removal, salinity intrusion on ground waters, impacts on coastal environment and resources, and effects of residues of chemical and drugs on health and the environment. In order to maintain trust on safety, quality and environmental concerns, preventive measures are taken to reduce the above hazard to environment and maintain the survival of aquaculture species. These measures include ICZM, farm design and management techniques, seawater irrigation systems, establishment of farmer associations, treatment of shrimp pond effluent, supportive government policies and regulation.

The Thai shrimp aquaculture industry has had an excellent record for the production of safe products of consistent quality. Techniques such as surveillance and inspection of final products do little to assure the food safety. The hazard analysis critical control point system (HACCP) enables aquaculturists and processors to exercise more control over food safety. HACCP is essentially a technique based upon anticipation and prevention of food safety hazards and it may be applied throughout the food chain from producer through to final consumer, leading to enhanced food safety and better use of resources.

The Department of Fisheries together with the aquaculture industry and processing industry has jointly developed preventive approaches to assure control over raw materials, the manufacturing process, the production environment, and personnel. It is based on the identification of potential hazards, application of control measures at critical control points (CCP), and monitoring and verifying of CCPs thereby enabling the assurance of food safety during culture and processing.

Application in shrimp farming

Black tiger shrimp *(Peneaus monodon)* is cultured for four to five months in earthern ponds and fed with formulated pellet feed. Water can be either changed continually throughout culture period or not at all i.e zero water discharge system. Permitted antibiotics

or chemicals may be used to treat shrimp at larval stages or when shrimp are found infected. Shrimp is harvested manually. Harvested shrimp is put in ice within 15 minutes after catch, it is then sorted and packed in ice and shipped to the processing factory. The process is depicted by Figure 1.

Haszard analysis

Specific hazards that may be encountered in shrimp aquaculture are shown in Table 1:

Applying HACCP

The potential hazards in aquaculture should be identified, and all activities associated with production, harvesting, processing, storage, distribution, and marketing evaluated. This includes a review of:

- The use of antibiotics, and other veterinary chemicals.
- Potential sources and specific points of bacterial contamination during production and processing.
- The potential for microorganisms to survive or multiply in aquaculture products.
- The risks and the severity of all hazards identified.

It is necessary to establish whether:

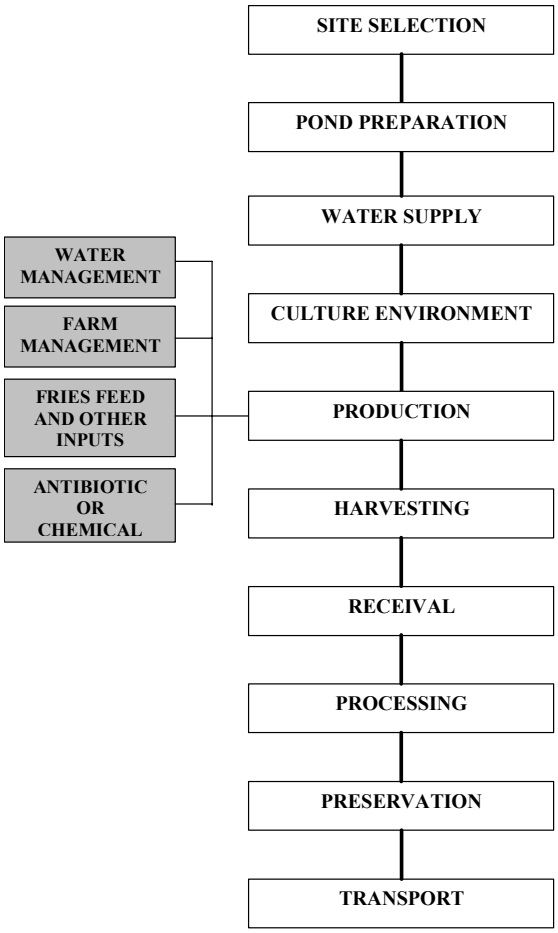
- Pathogenic microorganism/toxins may be present in raw materials.
- Pathogens may contaminate aquaculture products after harvest.

In Thailand it is recognized that specific hazards that may be encountered in shrimp aquaculture products include: Contamination by bacterial and viral parthogens e.g. Salmonella, *Vibrio cholerae*, and presence of antibiotics (and other substances) which may have potentially hazardous effects on consumers, handlers, and the environment.

It is largely accepted that the microbiological quality of the production environment impacts on the microbiological quality of the fish and ultimately the processed product. They represent a threat to human health when they are consumed raw, hence there is needed for control over production, harvesting, processing, and distribution.

Claims on the potential hazards from *Salmonella* and *Vibrio* species in the context of shrimp are conflicting. *Salmonella* and *Vibrio cholerae* are known to be part of the natural microflora of brackish water cultured shrimp, and pose a major concern for processors and exporters (Reilly and Kaferstein, 1997). In contrast, Salmonella has not been recovered

Figure 1: Generic aquaculture process flow chart and critical control points.



Note : Fry, feed, and other materials input such as lime, bacteria, premix, chemicals and permitted antibiotics are assessed as control points

Table 1: Hazards associated with cultured shrimp

Category	Examples of hazards	
Biological hazards	Pathogenic bacteria	Salmonella, Shigella, *E.coli, Vibrio cholerae, V.parahaemolyticus, V.vulnificus, Listeria monocytogenes,* etc
Chemical hazards	Veterinary residues	Hormones, growth regulators, antibiotics such as chloramphenical, nitrofuran and its metabolites and permitted antibiotics which residue is not over MRL.
	Pesticide residues	Herbicides, fungicides, insecticides, etc
Physical hazards	Glass, wood, metal, etc	

This is the company's newly acquired 18 million baht equipment for LC-MS-MS nitrofuran and metabolites analysis. The company's staff have been training with the fisheries department

Clearly, cultured crustaceans may present a threat to public health if they are not grown and harvested under hygienic conditions. Once harvested, aquaculture species are at risk from contamination in the processing plant with a wide range of pathogenic bacteria derived from the processing environment, water used in processing, equipment, and food handlers. There is need for more research to identify and assess potential hazards and to quantify the risks.

Antibiotic residues became of concern in 1992, when Japan's health authority rejected some shipments of shrimp products from Thailand and other Southeast Asian countries that were contaminated with oxytetracycline and oxoloinic acid. In 2002, Nitrofuran and chloramphenicol came under the spotlight of the European market. The US Food and Drug Authority expressed concerns over residues in shrimp. These prompted studies and a surveillance program to prevent these hazards initiated by the Department of Fisheries.

Preventive measures

Preventive measures, using HACCP concept, can be developed specifically to prevent drug residue and chemical contamination in aquaculture products and to prevent microbiological contamination at the farm and processing plants. Those measures are outlined as follows:

Controls at farm level

Measures taken:

1. Register farms
2. Control the uses of feed/antibiotics
3. Monitor residue in products from farm
4. Mobile unit control of diseases, use of antibiotic and feed
5. Monitoring the quality of water (both inlet and outlet of farms)
6. Inspect farm hygiene and post-harvest handling practices.
7. Train farmers on good aquaculture practices (GAP), safe use of chemotherapeutic agents and good handling practices

Farm registration

All shrimp farms must be registered and obtain permits to operate. General requirements include: Establishment of water treatment ponds; lay out approval by DOF; quality of water outlet does not exceed a biological oxygen demand of 20 mg/l; drainage of mud and brackish water to public water ways is not allowed; application of good farming practices; and farm hygiene and handling practices should be at a satisfactory level (based on Codex Guidelines on hygienic practices for the product of aquaculture).

Farm inspection

Farm inspection ensures that the farm observes required sanitation and operational standards. A farm sanitation checklist was developed based on Codex Guidelines and used in inspection. The criteria for inspection are:

Large scale farms of more than 8 ha must institute a farm management program which is approved by DOF. Farms are inspected by DOF two to four times a year to verify farm records.

Small farms (less than 8 ha.) are visited by a mobile unit inspection service. DOF operates 22 mobile units in major aquaculture areas, the units inspect approximately 8 farms a week and rotate their visits until all areas are covered, which often means not less than 5 inspections per farm over a year.

Table 2

Potential Critical Control Points	Preventive Controls	Responsible Division
Farm management	farm registration	Coastal Aquaculture and Fisheries Research and Development Bureau
Feed production	feed control	Feed Research and Control Institue
Farming practices	control uses of antibiotics	Coastal Aquaculture Health Research Institute
Farming practices	mobile unit control (monitor quality of water, antibiotic residue, shrimp) monitoring residue in raw material	Coastal Aquaculture and Fisheries Research and Development Bureau
Processing plants	inspection of processing establishment pre shipment inspection of finished products	Fish Inspection and Quality Control Division

Table 3

Country	Name	Maximum level (ppb)
EU	Nitrofuran (Metabolites)	(ppb)
	shrimp, prawn, fish	SEM = 1.00
		AHD = 1.00
		AOZ = 0.30
		AMOZ = 0.30
	References except Germany SEM 0.50 ppb	
	Chloramphenicol	(ppb)
	shrimp, prawn, fish	0.30
	References except Germany 0.20 ppb	
	Oxolinic acid	(ppm)
	fin Fish (only forzen fish)	0.30
	3-MCPD	(ppm)
	Fish sance, Oyster sance	0.02
Japan	Oxytetracycline	(ppm)
	shrimp, prawn, fish	0.20
	Oxolinic acid	(ppm)
	shrimp, prawn, fish	Not detected
Switzerland	Nitrofuran (Metabolites)	(ppb)
	shrimp, prawn, fish	SEM = 1.00
		AHD = 1.00
		AOZ = 0.30
		AMOZ = 0.30
	Chloramphenicol	(ppb)
	shrimp, prawn, fish	0.30
China	Nitrofuran (Metabolites)	(ppb)
	Culture shrimp, surimi	SEM = 1.00
		AHD = 1.00
		AOZ = 0.30
		AMOZ = 0.30
	Chloramphenicol	(ppb)
	Culture shrimp, surimi	0.30
USA	Chloramphenicol	(ppb)
	Culture shrimp	0.30
	Oxytetracycline	(ppm)
	Salmon, Catfish and Lobster	2.00
Canada	Nitrofuran (Metabolites)	(ppb)
	shrimp, prawn, fish	SEM = 1.00
		AHD = 1.00
		AOZ = 0.30
		AMOZ = 0.30
	Chloramphenicol	(ppb)
	shrimp, prawn, fish	0.30
	Oxytetracycline	(ppm)

Feed quality control

In order to prevent the use – inadvertent or intentional - of feed containing antibiotics, the following control measures are enforced: Registration of feed formulas; sampling feed/analysis for antibiotic residue (from plants and farms); and inspection of feed mills.

Farm monitoring

Twenty-two mobile units operated by them Coastal Aquaculture and Fisheries Research and Development Centers conduct surveillance and provide technical advice on: Farm sanitation monitoring; disease control; water quality monitoring at inlet and outlet; soil quality inspection and determination; quality of surrounding water; antibiotic residue in shrimp from pond; and use of feed and antibiotics. A farm sanitation rating report has been developed following the Codex Code of Hygienic Practices for the product of aquaculture.

Raw materials control

The effectiveness of the surveillance program at farm level is verified by determining the level of drug residue in shrimp raw materials from farms. The 17 units equipped with HPLC were set up in major aquaculture areas to inspect the quality of shrimp prior to harvesting. The activities include: Establish record of farm; sampling shrimp from farm (> 3 months) prior to harvesting to determine level of drug and chemical residue using microbioassay. A certificate of antibiotic-free raw materials will be given for shrimp that are drug free. One unit equipped with LC-MS-MS was set up to inspect nitrofuran in shrimp before harvesting.

Processing plant monitoring

To prevent microbiological hazards such as *Salmonella*, monitoring of processing plants are conducted. In addition to microbiological hazards, chemical hazards such as antibiotics and chemical residues, which are of concern to a verification program are prevented through monitoring of sanitation, hygiene and processing (p48)

What's New on the Web

Australian Aquaculture Portal

The Australian Aquaculture Portal has been developed in an attempt to centralise the growing body of information, research and business opportunities in the Australian Aquaculture Industry. An initiative of the Australian Aquaculture Council with funding from the Department of Agriculture, Fisheries & Forestry, this Portal is an essential reference tool for all those working in the Aquaculture Industry. It contains an overview of the major Australian industry sectors, contact details for industry associations and a comprehensive collection of links to relevant Australian and overseas sites for those wishing to 'dig a little deeper' into the complexities and opportunities this industry offers.

The member's section contains valuable information, research, contacts and dynamic information relating to what is currently happening around Australia. A comprehensive 'conference portal' is also included to keep members and others 'updated' with current and upcoming conferences. Here portal users can access information and register online as well as refer to white papers prepared by past and current conference speakers. As information in the public, members and conference parts of this site is updated weekly.

Commercial aquaculture farm owners and workers, students, vets, teachers, government bodies and advisors should all find this portal a valuable resource containing information that is 'database driven', therefore updated in a timely and systematic manner. http://www.australian-aquacultureportal.com/

Asian Fisheries Society

The new AFS website highlights fisheries events and publications, and abstracts of papers from the AFS journal Asian Fisheries Science are provided.

AFS is a scientific society organized in 1984 for fishery professionals in Asia to communicate, share information and cooperate with each other. Since its establishment, the Society has grown from the 14 charter members who signed the constitution to over 2,800 members from 75 countries and territories. Asia has been the leading world producer of fish. Its long history of fishing and fish farming has attracted several thousand scientists, researchers and students to the field of tropical fisheries and aquaculture. As their numbers grew, the need to improve interaction and cooperation among fisheries scientists and institutions became more apparent. Thus, the seeds for the Asian Fisheries Society were sown. http://www.asianfisheriessociety.org/

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practices of the plant and verification of end product quality. Monitored are:

- Sanitation, hygiene, good manufacturing practice as a basic quality control program.
- Processors must demonstrate a Quality Control program based on HACCP.
- Quality system verified by DOF.
- Processing plants are inspected 2-4 times/plant/year, for sanitation, hygiene practices, quality control system, laboratories and record at Critical Control Points and sanitation record. Those that pass the grade are included in the List of Approved Fish Processing Plants and issued an Approval Number.
- Sanitary Certificate and Certificate of Analysis of the shipment are issued, on request, to processing establishment and shipment that meet standard requirements.

Product monitoring

As required still, by import authorities, shipment of fishery products must be accompanied with a certificate stating the quality or laboratory results. This requires sampling and analysis of end products for safety, quality and wholesomeness.

For drug residue, shipments are examined by:

- Sampling for antibiotic residues of the group of tetracycline, penicillin and others using micro-bioassay
- Sampling for oxolinic acid using HPLC
- Sampling for chloramphenicol using HPLC
- Sampling for nitrofuran and its metabolites using LC-MS-MS

For microbiological hazards, shipments are determined for pathogenic bacteria and other microorganisms based on the requirements of the market. The maximum level for antibiotics and other contaminants imposed by a number of importing countries or blocks are as per table 3.

Conclusion

Preventing hazards to people's safety and health to human from cultured products can be made more effective by the application of HACCP at the farm, in other words, before the raw material even goes into the processing plant. Lima dos Santos (2002) said that HACCP can be applied through the food chain from primary production to final consumption but stressed that its implementation should be guided by scientific evidence of risks to human health.

A combination of measures are observed to prevent or control disease outbreaks. HACCP would be an effective complement to health management practices. HACCP application, along with observance of Good Aquaculture Practice (GAP) or Code of Conduct for sustainable aquaculture (CoC), enhance the overall effort at promoting sustainable and profitable aquaculture.

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