

Training Modules on Food Safety Practices for Aquaculture

# Food Safety Practices for Aquaculture

# Introduction

This module is part of a training program on Food Safety Practices for the Aquaculture Industry.

This program was developed through a partnership facilitated by the Partnership Training Institute Network (PTIN) of the Food Safety Cooperation Forum (FSCF) of the Asia Pacific Economic Cooperation (APEC) Forum. The educational content was designed by faculty at Michigan State University. Funding for this effort was provided by The World Bank Group.

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# Food Safety Practices for Aquaculture Production

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## Module Overview

In previous sections, food safety hazards that are commonly associated with aquaculture products have been discussed in general terms. The purpose of this section is to systematically address practices during aquaculture production that can impact food safety of the harvested fish, crustaceans or other products. This discussion will be general in nature and not specifically consider practices particular to shrimp, tilapia, catfish or other commonly farmed species. For species-specific considerations, the learner should refer to the appropriate section of the Codex Code of Practice for Fish and Fishery Products (Codex Standard CAC/RCP 52-2003) or other relevant texts.

The following topics will be discussed in this section:

- Food Safety Hazards – General Considerations
- Disease Prevention and Control – General Considerations
- Site Selection
- Growing Water Quality
- Source of Fry and Fingerlings
- Feed Supply
- Veterinary Drugs
- Growing Procedures
- Harvesting Procedures

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## Introduction

Aquaculture establishments should operate in a manner such that they comply with the recommendations of the Codex Code of Practice for Fish and Fishery Products (Codex Standard CAC/RCP 52-2003) in order to minimize the likelihood of potential food safety hazards during production, harvest and post-harvest handling of farmed fish.

Aquaculture operations should implement aquatic animal health management programs set up in compliance with relevant national legislation and regulations, and with the OIE (World Organization for Animal Health) Codes of Practice (OIE Aquatic Animal Health Code, 15th Edition, 2012) and taking into account the FAO CCRF Technical Guidelines on Health Management for Responsible Movement of Live Aquatic Animals

Fry and fingerlings should be disease free. Growing fish should be monitored for disease. Animal health considerations will be addressed briefly in this section but producers should refer to the appropriate codes of practice for more comprehensive information on diseases of fish, crustaceans and other farmed species as well as recommended methods for controlling these diseases.

When using chemicals at fish farms, special care should be exercised so that these substances are not released into the surrounding environment.

While the fish health, environmental and ecological aspects are important considerations in aquaculture activities and many international standards specify requirements for these aspects, this manual focuses on factors which impact food safety in aquaculture operations.

## Food Safety Hazards – General Considerations

As discussed in the previous module, consumption of fish and fishery products can be associated with a variety of human health hazards. Aquaculture products pose broadly the same hazards that are present in corresponding varieties caught in the wild.

The risk of harm from a particular hazard might be increased or decreased in aquaculture products compared with fish caught in the wild. The following are examples of different hazards that are generally associated with farmed compared to wild fish.

- Aquaculture products are at greater risk for contamination with veterinary drugs. This is particularly true if the withdrawal time for residues of veterinary drugs has not been observed or if unapproved veterinary drugs are used in production.
- High stocking densities during aquaculture, compared to wild populations, might increase the risk of cross-infection of pathogens within a population of fish.
- Infection with nematode parasites is much less likely to occur in farmed salmon compared with salmon caught in the wild.
- Contamination of fish with microbial pathogens of fecal origin can be more likely where the facilities are close to human habitation or animal husbandry, so farmed fish may be more likely to harbor these pathogens compared to wild fish if proper precautions are not taken.

## Disease Prevention and Control – General Considerations

Aquaculture operations can be susceptible to development and spread of animal diseases. There are several practices which can be used to minimize the potential for injection and spread of these animal diseases. Common practices can include the following:

- Zoning and/or compartmentalizing aquaculture operations. This is an approach that may be taken by country to establish and maintain a subpopulation of aquatic animals having a distinct health status (e.g. disease-free zones).
- Practicing appropriate disinfection procedures to eradicate or exclude specific diseases from aquaculture establishments and reduce disease incidence within aquaculture establishments.
- Fallowing, or providing for gaps in aquaculture production at the same location. Fallowing is a commonly recognized procedure that can break re-infection cycles by removing loci of a disease from a farm. Consequently, fallowing is often carried out as a regular disease management measure in aquaculture.
- Following appropriate procedures for handling, disposal and treatment of aquatic animal wastes.

Additional details on these practices and others to minimize the potential for aquatic animal diseases in aquaculture operations are available in the OIE Aquatic Animal Health Code.

## Site Selection

Appropriate site selection for aquaculture production is important to minimize potential food safety issues. The following are some considerations regarding site selection:

- The siting, design and construction of fish farms should follow principles of good aquaculture practice, appropriate to species.
- The physical environment with regard to temperature, current, salinity and depth should also be considered as different species have different environmental requirements. Closed recirculation systems should be able to adapt the physical environment to the environment requirements of the farmed fish species.
- Fish farms should be located in areas where the risk of contamination by chemical, physical or microbiological hazards is minimal and where sources of pollution can be controlled.
- Soil for the construction of earthen ponds should not contain such concentrations of chemicals and other substances that may lead to the presence of unacceptable levels of contamination in fish.



Photo: Serfling US FDA



## Site Selection

Considerations for aquaculture site selection (continued):

- Ponds should have separated inlets and discharge canals so that water supplies and effluent are not mixed.
- Adequate facilities for the treatment of effluent should be provided to allow sufficient time for sediments and organic load settlement before used water is discharged into the public water body.
- Water inlets and outlets to ponds should be screened to prevent the entrance of unwanted species.
- Fertilizers, liming materials or other chemicals and biological materials should be used in accordance with good aquaculture practice.
- All sites should be operated so as to produce fish that are safe for consumption (i.e. do not to cause adverse impacts on human health).



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## Growing Water Quality

Maintaining appropriate water quality is critical to minimizing the potential for chemical and microbiological contamination of fish produced by aquaculture. Following are some key considerations.

- The water in which fish are raised should be suitable for the production of products that are safe for human consumption.
- The water quality should be monitored regularly such that the health and sanitation of the fish is continuously maintained to ensure aquaculture products are safe for human consumption.
- Fish farms should not be sited where there is a risk of contamination of the water in which fish are reared.
- Appropriate design and construction of fish farms should be adopted to ensure control of hazards and prevention of water contamination.



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## Source of Fry and Fingerlings

The source of post-larvae, fry and fingerlings should be such to avoid the carryover of potential hazards into the growing stocks. In general, the same food safety practices outlined in these modules for aquaculture production, harvest and post-harvest handling apply equally to hatchery operations.

Although generally not a food safety issue, practicing appropriate disease control in hatchery operations is critical. These procedures could include testing stocks to establish freedom from pathogens or, when appropriate, to ensure that the prevalence of infection is below the threshold considered to cause a significant risk of disease outbreak. Use of specific pathogen-free (SPF) stocks is also recommended when possible. Additional guidance on aquatic animal disease control is available from the World Organization for Animal Health.



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## Feed Supply

Feeds used in aquaculture production can be potential sources of chemical contamination, mycotoxins and microbiological contamination if proper procedures are not followed. Feeds used in aquaculture production should comply with the provisions outlined in the Codex Code of Practice on good animal feeding (Codex Standard CAC/RCP 54-2004). When required, growers must also comply with statutory and buyer requirements.

Recommended practices in the Codex Code of Practice for Fish and Fishery Products include the following:

- Feed and fresh stocks should be purchased and rotated and used prior to the expiry of their shelf-life.
- Dry fish feeds should be stored in cool and dry areas to prevent spoilage, mould growth and contamination. Moist feed should be properly refrigerated according to manufacturer instructions.
- Feed ingredients should not contain unsafe levels of pesticides, chemical contaminants, microbial toxins, or other adulterating substances.

## Feed Supply

Recommended practices in the Codex Code of Practice for Fish and Fishery Products (continued):

- Industrially produced complete feeds and industrially produced feed ingredients should be properly labeled. Their composition must fit the declaration on the label and they should be hygienically acceptable.
- Feed and fresh stocks should be purchased and rotated and used prior to the expiry of their shelf-life.
- Ingredients should meet acceptable, and if applicable, statutory standards for levels of pathogens, mycotoxins, herbicides, pesticides and other contaminants that may give rise to human health hazards.
- Only approved colors of the correct concentration should be included in the feed.
- Moist feed or feed ingredients should be fresh and of adequate chemical and microbiological quality.
- When used as feed, fresh or frozen fish should reach the fish farm in an adequate state of freshness.

## Feed Supply

Recommended practices in the Codex Code of Practice for Fish and Fishery Products (continued):

- Fish silage and offal from fish, if used, should be properly cooked or treated to eliminate potential hazards to human health.
- Feed that is compounded industrially or at the fish farm should contain only such additives, growth promoting substances, fish flesh coloring agents, anti-oxidizing agents, caking agents or veterinary drugs that are permitted for fish by the official agency having jurisdiction.
- Products should be registered with the relevant national authority as appropriate.
- Storage and transportation conditions should conform to the specifications on the label.
- Veterinary drug and other chemical treatments should be administered in accordance with recommended practices and comply with national regulations.
- Medicated feeds should be clearly identified on the package and stored separately, in order to avoid errors.
- Farmers should follow manufacturer instructions on the use of medicated feeds.
- Product tracing of all feed ingredients should be assured by proper record-keeping.

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## Veterinary Drugs

Residues of certain therapeutic agents can accumulate in fish tissue and present a potential health hazard to humans. Therefore, certain compounds have been banned, and residue limits mandated for others. Failure to comply with regulations on veterinary drug use can lead to product rejections and therefore have serious economic consequences.

As was discussed in previous sections, certain drugs are not allowed in aquaculture production but nevertheless have been used extensively and have resulted in numerous recalls and border rejections of aquaculture products. Chloramphenicol and nitrofurantoin antibiotics are banned for use in food production in all countries.

Producers must comply with all applicable regulations concerning the use of veterinary drugs, including requirements of importing countries if they are exporting aquaculture products. For example, a list of approved aquaculture drugs by the U.S. Food and Drug Administration is available at:

<http://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/Aquaculture/ucm132954.htm>



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## Veterinary Drugs – Recommended Practices

- All veterinary drugs for use in fish farming should comply with national regulations and international guidelines (in accordance with the Recommended International Code of Practice for control of the use of veterinary drugs (Codex Standard CAC/RCP 38-1993) and the Guidelines for the establishment of a regulatory programme for control of veterinary drug residues in foods (Codex Standard CAC/GL 16-1993).
- Prior to administering veterinary drugs, a system should be in place to monitor the application of the drug to ensure that the withdrawal time for the batch of treated fish can be verified.
- Veterinary drugs or medicated feeds should be used according to manufacturer instructions, with particular attention to withdrawal periods.
- Products should be registered with the appropriate national authority.
- Products should only be prescribed or distributed by personnel authorized, such as a veterinarian or fish health specialist, under national regulations.
- For exported products, therapeutic agents approved for use in producing countries may only be used if they are not banned in importing countries and residues in fish products do not exceed limits set by importing nations.



## Veterinary Drugs – Recommended Practices

- Storage and transportation conditions for therapeutic agents should conform to the specifications on the label.
- Control of diseases with drugs should be carried out only on the basis of an accurate diagnosis and by personnel, such as a veterinarian or fish health specialist, authorized under national regulations
- Records should be maintained for the use of veterinary drugs in aquaculture production. Required records for every application of drugs and other chemicals should include the treatment start date, treatment stop date, compound used, reason(s) for use, dose, identity of ponds or cages where the drug was applied, and harvest date for the treated ponds or cages.
- For those fish which tested with drug residue concentrations above the maximum residue limit (MRL) (or, in some countries, by an industry imposed lower level), harvest of the batch should be postponed until the batch complies with the appropriate MRL. After an assessment of the good aquaculture practices regarding pre-harvest measures, appropriate steps should be taken to modify the drug residue control system.
- A post-harvest control should reject all fish that do not comply with the requirements set for veterinary drug residues by the relevant national authority.

## Growing Procedures

Appropriate growing procedures must be followed to minimize the potential for microbiological and chemical contamination during aquaculture production.

The following practices are recommended in the Codex Code of Practice for Fish and Fishery Products.

- Source of post-larvae, fry and fingerlings should be controlled to ensure healthy stock.
- Stocking densities should be based on culture techniques, fish species, size and age, carrying capacity of the fish farm, anticipated survival and desired size at harvesting.
- Diseased fish should be quarantined when necessary and appropriate; dead fish should be disposed of immediately in a sanitary manner that will discourage the spread of disease and the cause of death should be investigated.
- Good water quality should be maintained by using stocking and feeding rates that do not exceed the carrying capacity of the culture system.

## Growing Procedures

Codex Code of Practice for Fish and Fishery Products recommended practices (continued):

- Growing water quality should be monitored regularly so as to identify potential hazards and defects.
- The fish farm should have a management plan that includes a sanitation program, monitoring and corrective actions, defined fallowing periods, appropriate use of agrochemicals, verification procedures for fish farming operations and systematic records.
- Equipment such as cages and nets should be designed and constructed to ensure minimum physical damage of the fish during the growing stage.
- All equipment and holding facilities should be easy to clean and to disinfect and should be cleaned and disinfected regularly and as appropriate.

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## Growing Procedures

The following are some additional specific recommendations that will help minimize the potential for chemical contamination in grow out ponds.

- Pesticides, heavy metals and other chemicals applied during previous land use can remain in the land's soil and water in small amounts and be taken up by fish in production ponds. The potential for this type of contamination should be assessed when new sites are being considered for pond construction.
- Taking steps to minimize disease will consequently reduce the likelihood that therapeutic agents are required for disease management. The use of practices such as disease monitoring in fry and fingerlings, adoption of fallowing and "all in, all out" stocking procedures at cage and net pen sites, maintaining good water quality, and limiting water exchange between ponds reduces the risk of spreading disease.
- Farms should not use uncooked organisms and their by-products or trash fish as feed in fish ponds, as this practice can encourage the spread of fish diseases.

## Growing Procedures

The following are some additional specific recommendations that will help minimize the potential for microbiological contamination in growout ponds. Note that the World Health Organization has published guidelines on the safe use of wastewater and excreta in aquaculture.

- Sewage contains microorganisms that can be harmful to humans. There is a possibility of health hazards to humans who consume inadequately cooked fish grown in waters that have been contaminated with human waste, untreated animal manure or organic fertilizers containing *Salmonella* or other microorganisms capable of causing human illness.
- Raw sewage shall not be discharged into fish ponds, farm canals or natural waters. Runoff from barns and other facilities for holding livestock shall not enter ponds.
- Domestic animals other than family pets or watch dogs shall not circulate freely within farms. Standards commonly permit livestock in pastures that serve as pond watersheds, but in these cases fences must be installed to prevent animals from drinking or wading in aquaculture ponds.
- It is commonly recommended in the aquaculture industry that only chemical fertilizers, properly treated organic manure and pelleted feeds be used in aquaculture ponds. For example, farms certified under the Aquaculture Certification Council's BAP standard are not allowed to use any untreated manure or uncooked organisms in growout ponds.

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## Harvesting

Harvesting of farmed fish, crustaceans and other aquaculture products must be conducted in a manner that minimizes potential contamination with chemical or microbiological hazards.

After harvest, the fish must be held, packed and transported under conditions that minimize the potential for contamination with potential chemical and microbiological hazards. Appropriate time and temperature control is essential to minimizing the proliferation of microbial pathogens and spoilage microorganisms.

Several considerations for harvesting equipment, facilities and practices follow.



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## Harvesting Equipment and Facilities

- All surfaces in handling areas should be non-toxic, smooth, impervious and in sound condition in order to minimize the buildup of fish slime, blood, scales and guts and to reduce the risk of physical and microbial contamination.
- Where appropriate, adequate facilities should be provided for the handling and washing of fish and shellfish and should have an adequate supply of cold potable water or clean water for that purpose.
- Adequate facilities should be provided for washing and disinfecting equipment, where appropriate.
- Where appropriate, containers for offal and waste material should be clearly identified, suitably constructed with a fitted lid and made of impervious material.
- Separate and adequate facilities should be provided to prevent the contamination of fish and shellfish and dry materials, such as packaging, by poisonous or harmful substances, offal and waste materials.
- Adequate hand washing and toilet facilities, isolated from the fish and shellfish handling areas, should be available where appropriate.
- Prevent the entry of birds, insects or other pests, animals and vermin, where appropriate.

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## Harvesting Equipment and Facilities

Other considerations to minimize damage of aquaculture products during harvesting and post-harvest handling include the following:

- Seines, nets and traps used for harvest should be carefully selected to ensure minimum damage during harvesting.
- Harvesting areas and all equipment for harvesting, catching, sorting, grading, conveying and transporting of live products should be designed for their rapid and efficient handling without causing mechanical damage. These should be easily cleanable and free from contamination.
- Conveying equipment for live and slaughtered products should be constructed of suitable corrosion resistant material that does not transmit toxic substances and should not cause mechanical injuries to them.



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## Harvesting Procedures

- Appropriate harvesting techniques should be applied to minimize physical damage and stress.
- Live fish should not be subjected to extremes of heat or cold or sudden variations in temperature and salinity.
- Fish should be free from excessive mud and weed soon after being harvested by washing with clean seawater or freshwater under suitable pressure.
- Fish should be purged, where necessary, to reduce gut contents and pollution of fish during further processing.
- Fish should be handled in a sanitary manner according to the guidelines in Section 4 of the Code.
- Harvesting should be rapid so that fish are not exposed unduly to high temperatures.
- All equipment and holding facilities should be easy to clean and to disinfect and should be cleaned and disinfected regularly and as appropriate.

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## Time and Temperature Control

Temperature is the single most important factor affecting the rate of fish and shellfish deterioration and potential multiplication of microorganisms including those that can cause human illnesses. For fish species prone to scombrototoxin production, time and temperature control may be the most effective method for ensuring food safety. Therefore, it is essential that fresh fish, fillets, shellfish and their products that are to be chilled should be held at a temperature as close as possible to 0 °C.

To minimize deterioration, it is important that:

- Chilling should commence as soon as possible.
- Fresh fish, shellfish and other aquatic invertebrates should be kept chilled, processed and distributed with care and minimum delay.
- Where ice is used in chilling operations, it must be produced from potable water.

## Time and Temperature Control

Where temperature control is concerned:

- Sufficient and adequate icing, or chilled or refrigerated water systems where appropriate, should be employed to ensure that fish, shellfish and other aquatic invertebrates are kept chilled at a temperature as close as possible to 0 °C.
- Fish, shellfish and other aquatic invertebrates should be stored in shallow layers and surrounded by finely divided melting ice.
- Fish and shellfish that are transported live should be held and transported at temperatures tolerable for the species.
- Chilled or refrigerated water systems and/or cold storage systems should be designed and maintained to provide adequate cooling and/or freezing capacities during peak loads.
- Fish should not be stored in refrigerated water systems to a density that impairs its working efficiency.
- Monitoring and controlling the time and temperature and homogeneity of chilling should be performed regularly.

## Holding and Transportation

The following are general considerations that apply to holding and transportation of aquaculture products in a manner that will minimize potential contamination with chemical or microbiological hazards, and also minimize stress and physical damage to the fish.

- All equipment and holding facilities should be easy to clean and to disinfect and should be cleaned and disinfected regularly and as appropriate.
- Fish should not be transported with other products that might contaminate them.
- Fish should be transported without undue delay.
- Equipment for the transportation of live fish should be designed for rapid and efficient handling without causing physical damage or stress.
- Fish should be handled in such a way as to avoid unnecessary stress.
- Records for transportation of fish should be maintained to ensure full product tracing.

More detailed considerations on transportation conditions for specific aquaculture products are discussed in the Codex Code of Practice for Fish and Fishery Products.

## References

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