As aquaculture makes its transition to become a major food producing sector, proper assessment and control of any food safety concerns is becoming increasingly important.

A Joint FAO/NACA/WHO Study Group on Food Safety held a workshop in Bangkok recently and considered food safety issues associated with farmed finfish and crustaceans. The Mekong River Commission participated in the workshop. The focus was on health hazards related to biological and chemical contamination that occur during the production of these aquatic products. It considered the quantification of hazards and how to implement measures for control of potential food safety hazards, including current national and international programmes. It did not address issues concerning farmed mollusc or seaweeds.

Food-borne diseases are a major public health problem which causes considerable morbidity and mortality worldwide. Hundreds of millions of people suffer from communicable and non-communicable diseases caused by contaminated food. These diseases take a heavy toll in human life and suffering, particularly among infants and children, the elderly and other susceptible individuals. They also create an enormous social, cultural and economic burden on communities and their health systems.

Fish and Crustaceans are Generally Safe, But…..

Fish and crustaceans are generally regarded as safe nutritious foods, but products from aquaculture have some times been associated with a number of food safety issues, as the risk of contamination of products by chemical and biological agents is greater in freshwater and coastal ecosystems when compared to the open seas. There are many different methods of farming fish, ranging from extensive small-scale or subsistence systems to intensive commercial operations. Food safety hazards will vary according to the system of culture, management practices and environment. Food-borne diseases associated with pathogenic bacteria, residues of agro-chemicals, veterinary drugs and heavy metal organic or inorganic contamination have been identified as hazards. The reasons for such food safety concerns are diverse, ranging from waste-fed aquacultural practices, environmental pollution and cultural habits of food preparation and consumption. As aquaculture has been growing at such a rapid rate, there has been more widespread dissemination of traditional semi-intensive farming systems, particularly in rural areas, including various integrated and wastewater-fed systems.

The principal biological agents that cause food-borne diseases are bacteria, viruses, parasites and to a lesser extent, moulds. Bacteria can cause food-borne diseases by direct infection, where ingested organisms colonize the gastrointestinal tract and cause typical symptoms such as nausea, diarrhea, vomiting resulting from the ingestion of pre-formed toxins in foods. There are a wide variety of bacteria that are usually related to seafood-borne diseases, ranging from those resulting from faecal pollution of the aquatic environment to those such as *Vibrio* spp., that are naturally present in coastal and estuarine ecosystems.

Most viruses that cause food-borne infections are transmitted by the faecal-oral route. The food-borne viruses associated with sea foods are the Hepatitis A and Norwalk-like viruses, and these are more commonly attributed to mollusc shellfish consumption, rather than finfish or crustaceans. Rotaviruses are a common cause of infant diarrhea in developing countries. Moulds have not been implicated in seafood-borne diseases. However, they can produce mycotoxins in dried foods and these could be of importance in fish feeds.

Salted fish stuffed with lemon grass and herbs needs to be thoroughly grilled to ensure that the consumer will be safe from food-borne diseases.
Highly relevant to most of the aquaculture systems covered by the Mekong River Commission is the analysis of food-borne parasitic diseases. These are a global public health problem that affect millions of people, particularly in developing countries. Poor standards of sanitation and hygiene, low education and poverty, all favour the spread of parasitic diseases that are related to food consumption. Cultural habits of food preparation play an important role in the transmission of parasitic food-borne disease, as do agricultural and aquacultural production methods.

**Consumption of Raw Fish Causes Infection**

A large number of fish species, both marine and freshwater, can serve as a source of food-borne parasitic infections. Some of these parasites are highly pathogenic and the main cause of human infection appears to be the consumption of raw or inadequately fish. It is evident that these infections are prevalent in communities where eating raw fish is a cultural habit. Generally, fish are the intermediary hosts of these parasites and, in such incidences, man becomes the definitive host of the parasite. The main human diseases caused by these parasites are trematodiasis and nematodiasis. Fish-borne trematodiasis is an important disease in various parts of the world. Although the disease is seldom fatal, trematodes can cause morbidity and serious complications leading to mortality among humans. The route of infection is through the ingestion of viable encysted metacercariae of parasites, which are generally found in the flesh of raw, inadequately cooked or semi-processed freshwater fish. The two major types detrimental to human health are *Clonorchis* and *Opisthorchis*. Clonochiasis, the disease caused by *Clonorchis*, is endemic in some countries in East Asia as China including Taiwan, the Republic of Korea, and Northern Viet Nam (WHO, 1995) and may not be confined to these countries. Only one parasite, *C. sinensis*, is reported to cause human infections. The distribution of this parasite within the endemic countries appears to be associated with its main but not the sole snail host, *Parafossaulus man-chouricus*. Transboundary movement of infected fish can spread the disease much further than its original endemic distribution.

**80 Fish Species Can Transmit Parasites**

More than eighty species of freshwater fish act as secondary intermediate hosts to *Clonorchis sinensis*, and these include 71 species of *Cyprinidae*, two species each from the families *Ophioccephalidae* and *Eleotridae*, and one species each from the following families: *Bagridae*, *Cyprinodontidae*, *Clupeidae*, *Osmeridae*, *Cichidae* and *Gobiidae*. Some of these species are of aquacultural importance. It has also been reported that the traditional practice of building latriunes above carp ponds and the use of night soil for pond enrichment maintain the infection in the cultured fish population. Besides man, several species of mammals such as pigs, cats, dogs and rats serve as hosts of the parasite. Parasitic larvae are excreted out in the feces of these mammals and ingested by freshwater snails. After multiplication in the intermediate snail host, free-swimming *Cercariae* are released and these may penetrate beneath the scales of fish to form metacercarial cysts within the muscle tissues. When raw or inadequately cooked fish are eaten by man, the cysts get into the small intestine and migrate up the bile duct causing clinical disease. *Clonorchis metacercariae* in fish tissue may persist for a considerable length of time and can survive for two to three months if frozen, for a few weeks if dried, and for several days if salted or pickled in soy source and vinegar. They are killed by adequate cooking and steaming of infected fish. Considerable epidemiological data are available on *C. sinensis* infection in man. Most of this information indicates that wild fish are often a secondary host. However, some recent reports note that farmed *Cyprinus* are also important secondary fish hosts.

**Food Safety Management Strategies Needed**

As mentioned earlier, the human health hazards from the parasites are mostly focused on communities where eating of raw fish is a cultural habit. In fact, control of these parasites are theoretically very easy. Because the infection can only be contracted by ingestion of encysted metacercaria when the raw fish are eaten, the most practical method of preventing human infection is to avoid eating raw or inadequately cooked or semi-processed fish. However, it is difficult to carry out such simple measures in the face of century-old traditions, to which the populations cling with great tenacity. Considering the nature and the species of fish which act as intermediary hosts to these parasites, and the type of aquaculture systems involved, it is clear that the only rational way of controlling these parasitic infections in man should be towards changing the food habits of the communities in question. Fish-borne parasitic infections in humans could be reduced by applying certain improvements to the culture systems; providing necessary multidisciplinary assistance to affected or vulnerable rural communities; and application of a HACCP (Hazard Analysis Critical Control Point) based system.

**HACCP Difficult in Subsistence Production**

Identification of ways and means to bring about the application of HACCP based safety control systems, especially in subsistence types of aquaculture, is a major challenge. It may not be difficult to apply the HACCP-based system to large-scale commercial aquaculture ventures. However, in small-scale subsistence aquaculture systems where fish are mainly farmed for domestic consumption application of an effective HACCP-based system will certainly pose considerable difficulties. There fore, the design and implementation of such systems should be considered following careful evaluation of the feasibility of applying such a control system to a particular aquaculture system, the risks associated with system components and procedures, and identifying the correct critical control points. Some preliminary experiments have been conducted to test the application of the HACCP-based control system in selected fish ponds to control fish-borne trematode infections in Thailand and in Viet Nam. However, further experiments designed scientifically to include adequate statistical analysis and replication should be conducted to evaluate the effectiveness of the HACCP-based control in small-scale subsistence type aquaculture.
Improved Aquaculture Practices Required

Promotion of the use of parasite free fingerlings in endemic areas, and reduction or avoidance of entry of snails and wild fish which are susceptible to parasitic infection could improve the conditions of the farming system. Appropriate sanitary practices, including eliminating intermediary hosts by using appropriate disinfectants, and application of possible biological control agents such as mollusc eating fish into aquaculture ponds could provide additional protection.

Traditional Food Habits Must Be Changed

It is imperative that the fish farmers are properly trained to apply measures to control parasites. Extension officers, relevant NGOs and other government officials concerned should be trained so that an effective parasite control extension programme can be implemented. The farmers should also be trained to produce healthy fingerlings and maintain a hygienic pond environment. It is important that a coordinated, multidisciplinary training programme involving fish farmers, public health workers and nutritionists is conducted in order to improve the overall knowledge of the host-parasite relationship, general hygiene and public health among different sectors of the community. Implementation of mass media-based awareness programmes will undoubtedly help rural farmers to improve their knowledge in public health and pathogen control. Furthermore, attempts should be made to change the traditional food habits which are preconditions to parasitic infections.

Public Health Education Must Be Strengthened

In endemic areas, communities should be offered adequate health education by the relevant government authorities. Mass treatment and public awareness programmes with the participation of non-governmental organisations (NGOs), rural societies, and other appropriate sectors could improve the knowledge of the farmers and their families.

Regulatory Frameworks within Endemic Areas

It is appropriate to formulate regulatory frameworks within endemic areas to encourage the hygienic disposal of human wastes, and other waste products which are directly or indirectly concerned with parasite infections. However, these regulatory measures should be supported by adequate training, research and awareness programmes.

More Information Is Needed

Aquaculturists in the endemic areas may have limited knowledge on the public health problems caused by fish-borne parasitic diseases, such as Clonorchiasis and Opisthorchiasis.

- Collaboration among public health authorities, food safety services, fishery and aquaculture officials and farmers is desirable to improve the awareness of fish-borne parasitic disease risks among endemic and other communities. There is a great need for information to explain the problem and possible solutions to various sectors of the society, including the general public. Extension manuals for farmers should be developed with specific messages on food safety procedures.

- Practical experiments on the possible use of the HACCP-based control systems should be carried out in order to check the feasibility and efficiency in controlling different fish-borne parasites in different aquaculture systems.

- Success would largely depend on collaboration among the agencies responsible for public health, fisheries, aquaculture, food safety (fish inspection) and public education. To meet the challenge of eliminating fish-borne parasitic infections in humans, fish inspection programmes in endemic areas should be strengthened. Fish inspectors must be informed about the hazards of fish-borne parasitic infections and adequate training should be provided on ways and means of controlling their occurrence. Monitoring of relevant critical control points of production, handling, processing and marketing operations should be conducted.

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