COFI:AQ/II/2003/6

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May 2003

منظمة الأغذية والزراعة للأمم المتحدة | 联合国粮食及农业组织 | Food and Agriculture Organization of the United Nations | Organisation des Nations Unies pour l'alimentation et l'agriculture | Organización de las Naciones Unidas para la Agricultura y la Alimentación

# COMMITTEE ON FISHERIES

## SUB-COMMITTEE ON AQUACULTURE

## Second Session

## Trondheim, Norway, 7-11 August 2003

# STRATEGIES TO IMPROVE SAFETY AND QUALITY OF AQUACULTURE PRODUCTS

***SUMMARY***

Improvement of the safety and quality of aquaculture products has become a significant concern to aquaculture development and trade globally. During the First Session (2002) of the Sub-Committee on Aquaculture, many delegates stressed that the issue of food quality, product safety and certification is highly important for international trade and access to foreign markets, especially for developing countries. This paper highlights the key issues pertaining to the safety and quality of aquaculture products, outlines strategies to improve the safety of aquaculture products, attempts to assess the contribution and efforts of FAO and the various stakeholders. Through this document, FAO seeks guidance from the Sub-Committee on how to continue to shape FAO's role in the process of improving safety and quality of products from aquaculture.

## INTRODUCTION

1. During its First Session (2002), the Sub-Committee on Aquaculture identified assurance of health for both the environment and consumers of aquaculture products as a key factor in developing sustainable aquaculture and many delegates stressed the issue of food quality, product safety and certification which has important considerations for international trade and access to foreign markets, especially for developing countries. Several delegates stated that access to markets should be fair and that import/export standards on, *inter alia*, food quality, should be



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harmonized, based on available scientific evidence, in order to avoid non-tariff trade barriers [(1)]. The objectives of this paper are to highlight the key issues pertaining to the safety and quality of aquaculture products, outline strategies to improve the safety of aquaculture products, to assess the contribution and efforts of FAO and the various stakeholders and to seek the guidance of the Sub-Committee on how to continue to shape FAO's role in the process.

2. Globalization of food trade, coupled to technological developments in food production, handling, processing and distribution and the increasing awareness and demand of consumers for safe and high quality food have put food safety and quality assurance high in the headlines. This is exacerbated by the sequels of the food safety scares of the 1990s (bovine spongiform encephalopathy (BSE) and dioxins) and by concerns over technological innovations from biotechnology (genetically modified organisms). Consumers are adamant over their right to choose and to have the means to make informed decisions over quality and safety of food products. They want to be informed and to participate in the making of policy decisions on food safety and quality.

3. Fish products in general and aquaculture products in particular have been subject to close scrutiny for their safeness for consumption within international fish trade. For example, the European Union (EU) alert system for food and feed [(2)] indicated that fish and fishery products were responsible in 2002 for the largest category (over 25 percent) of food safety and quality alerts. Of these, aquaculture products were particularly targeted for veterinary drug residues and the EU banned the import of aquaculture products from various countries, which led to a significant disruption of trade flows and risks of retaliatory measures to counter what many exporting countries considered a technical barrier to trade.

4. Likewise, the farming of fish high up in the food chain leads to a concentration of contaminants. For example, "fish meal and fish oil were found to be the most heavily dioxin contaminated feed materials with products from European fish stocks contaminated more heavily than those from South Pacific"[(3)]. In the UK, the Food Standards Agency has been advising consumers only to eat one portion of oily fish per week, and the EC has launched a programme to test for PCBs and dioxins in a range of fish including Chilean, Norwegian, Canadian and Scottish farmed salmon.

5. Public concern is also growing because of the use of genetically modified (GM) soybean products in aquafeeds. Due to the foreseen global shortage of fish meal and fish oil and the problems caused by excessive feed waste, attention is turning to plant-based sources of proteins and fats as supplements. The current nutritional imbalances and palatability problems associated with low fishmeal/fish oil feed formulations may be overcome in the future, but some foresee that long-term solutions may require genetic engineering to propagate plants with a more suitable profile of amino acids and fatty acids.

## IMPORTANCE AND DIVERSITY OF AQUACULTURE SYSTEMS

6. Aquaculture comprises diverse systems of farming plants and animals in inland and coastal areas. The benefits of aquaculture in rural development relate to health and nutrition, employment, income, reduction of vulnerability and farm sustainability. Aquaculture, particularly the farming of herbivorous/omnivorous fish in smallholder systems, provides high quality animal protein and essential nutrients, especially for vulnerable groups and poorer segments of the community at prices affordable to all. It creates 'own enterprise' employment, including for women and children, and provides income through sale of what can be a relatively high value product. Income through employment opportunities is possible on larger farms, in seed supply

[1] FAO, 2002. Committee on Fisheries. Report of the first session of the Sub-Committee on Aquaculture. Beijing, People's Republic of China, 18-22 April 2002. Fisheries Report No 674
[2] European Union, 2003. Rapid alert system for food and feed. Report for the year 2002. 30 pages
[3] European Union 2000, Opinion of the scientific committee on animal nutrition on the dioxin contamination of feeding stuffs and their contribution to the contamination of food of animal origin adopted on 6 November 2000.

networks, market chains and various service provider functions. Indirect benefits include an increased availability of fish in local rural and urban markets and concomitant reduction in price allowing savings to be spent on other income generating farm products. Aquaculture can also offer benefit from the utilization of common resources, particularly for the landless, through cage culture, culture of molluscs and seaweeds, and enhanced fisheries in communal waterbodies. An important, although often overlooked benefit, which is particularly relevant for integrated agriculture-aquaculture systems, is their contribution to increased farm efficiency and sustainability. Agricultural by-products such as manure from livestock and crop residues can serve as fertilizer and feed inputs for small-scale and commercial aquaculture. Fish farming in rice fields contributes to integrated pest management and integrated management of vectors of human medical importance.

7. Extensive to semi-intensive aquaculture systems produce the bulk of global aquaculture products. Extensive farming usually involves simple methods, relies on natural food and has a low input to output ratio. As production intensity increases, fish are purposely stocked and the natural food supply is enhanced by using organic and inorganic fertilizers and low-cost supplemental feeds from agricultural by-products. The most frequently found system is the farming of fish in ponds, but rice-fish farming and stocking of fish into natural or impounded waterbodies are also common.

8. Intensive aquaculture systems yield more output from a given production unit. This is achieved through the use of technology and a higher degree of management control, which typically involves well-designed facilities operating with higher stocking densities and the use of compound manufactured feed and good health management on a regular basis. Intensive inland and coastal cage aquaculture of high-value salmonids has been encouraged and supported to develop remote rural areas in Europe and South America. Similar systems have emerged in Asia and Australia for warm-water piscivorous fish such as groupers, yellowtail, snappers and sea bass. Coastal shrimp farming which is often carried out in remote areas has raised particular interest throughout the tropics because of its high value and opportunities for export and earning foreign exchange.

9. In view of the benefits it is not surprising that aquaculture production has grown rapidly since the 1970s, and has been the fastest growing food production sector in many countries for nearly two decades; the sector exhibiting an overall growth rate of over 11.0 percent per year since 1984, compared with 3.1 percent for terrestrial farm animal meat production, and 0.8 percent for landings from capture fisheries. The majority of the food fish production comes from land-based freshwater culture, and in some countries it exceeds that from freshwater capture fisheries. Currently, over 80 percent of world aquaculture production originates from developing countries. The rapid growth in aquaculture production and trade has made the sector important to the local economies of many developing countries. Over the years, aquaculture products have helped to stabilize traded fish supplies and to bring down prices. This has not only helped in expanding markets, but also made what was previously considered luxury products available at lower prices to the general public.

## MAJOR SAFETY AND QUALITY CONCERNS OF AQUACULTURE PRODUCTS

10. Safety and quality assurance programmes are aimed at preventing and controlling safety hazards and product defects. A hazard is a biological, chemical or physical agent in, or condition of food, with the potential to cause an adverse health effect; whereas a defect means a condition found in a product which fails to meet essential quality, composition and/or labelling provisions of the appropriate product standards [(4)].

11. Broadly, the same hazards and defects are present in both wild-caught and cultured products. Under certain circumstances the risk of harm from a particular hazard might be

[4] FAO, 2003. Report of the twenty-fifth session of the Codex Committee on fish and fishery products. Ålesund, Norway, 3 - 7 June 2002. Alinor 03/18.

increased in aquaculture products compared to those caught in the wild. The presence of residues of veterinary drugs in excess of recommended levels and contamination with hazardous microflora originating from human or animal waste are some of those risks. Yet, it is the manure-driven systems which have evolved over millennia as sustainable food production systems. Whilst the levels of micro-organism in manure or pond water are important in understanding risks to the producer, the level of pathogens contained in the fish at harvest is of key importance in determining risk to those preparing and consuming the fish. On the other hand, farmed fish can also present a lower risk of harm. In intensive systems where fish are fed artificially, the risks associated with transmission of many hazards through feed are reduced. Raising fish in cages in the marine environment poses few hazards and low risks. In closed recirculation systems hazards are even further reduced [5,6,7]. However, it is important to note here that the majority of cultured products originate from extensive and semi-intensive systems such as ponds and integrated systems.

12. Fish spoilage of cultured and wild fish follow the same pattern, and some cultured fish show seasonal variations, in terms of shelf life. However, the possibility of choosing better slaughter and chilling procedures allow us to improve the post-harvest quality of cultured products. Using artificial feed, it is also possible to control the flesh colour, odour, flavour, texture, nutritional quality, fat content, fat profile, proximate composition (mainly through fat) etc., compared with those of wild-caught fish. Mechanical damage of cultured fish is less compared with those hauled in a net or trapped in gill nets for extended periods.

13. Food safety hazards from aquaculture products can be biological, chemical or physical. Biological hazards comprise parasites and microbiological hazards (bacterial or viral). Parasites have complex life cycles, involving one or more intermediate hosts and are generally passed to humans through the consumption of raw, minimally processed or inadequately cooked products that contain the parasite's infectious stage. The parasites known to cause disease in humans and transmitted by fish or crustaceans are commonly referred to as nematodes, cestodes and trematodes. Fish-borne trematode (flatworm) infection is a public health problem that occurs in many countries around the world, especially among the communities where raw or inadequately cooked fish are eaten. The most important definitive hosts of these trematodes are man or other mammals.

14. Some of these diseases are endemic to some countries in East Asia, such as China (including Taiwan Province of China), the People's Republic of Korea and Northern Vietnam but are not necessarily confined to these countries. Trans-boundary movements of infected fish have spread the disease beyond its original area of distribution. The traditional practices of building latrines above carp ponds and using nightsoil as fertilizer helped to maintain infections in cultured fish populations, while cultural practices of consuming raw or inadequately cooked fish products continued to keep infections in rural populations[8, 9, 10]. Adopting a strategy of using livestock wastes in fish culture has already made important contributions to improving health and hygiene in various countries. In Taiwan Province of China, for example, economic growth with improved sanitation and increasing livestock production have led to replacement of human waste with pig and poultry manure as fertilizers in fish culture over the last few decades[11]. Particularly integrated

[5] WHO, 1999. Food safety issues associated with products from aquaculture. Report of a joint FAO/NACA/WHO study group. WHO Technical report Series 883. 55 pages

[6] FAO, 2003. FAO's strategy for a food chain approach to food safety and quality: a framework document for the development of future strategic direction. Committee on Agriculture. Seventeenth session. Rome. 31 March-4 April 2003

[7] M.L. Jahncke; E. Spencer Garett; Alan Reilly; Roy E. Martin and Emile Cole, 2002. Public, animal and environmental aquaculture health issues. Wiley-Interscience. USA

[8] FAO, 2003. Report of the twenty-fifth session of the Codex Committee on fish and fishery products. op.cit.

[9] WHO, 1999. Food safety issues associated with products from aquaculture. op.cit.

[10] M.L. Jahncke; E. Spencer Garett; Alan Reilly; Roy E. Martin and Emile Cole, 2002. op.cit.

[11] FAO 2003. Integrated livestock-fish farming systems – The Asian experience and its relevance for other regions, by D.C. Little and P. Edwards. Inland Water Resources and Aquaculture Service and Animal Production Service. FAO, Rome, Italy. 206 pp. (in press)

livestock and fish systems with ducks efficiently control the intermediate snail hosts and thus break the life cycle of the parasite[12]. Another good management practice contributing to the biological control of the intermediate hosts is the stocking of mollusc-feeding fish species. Education and awareness-building among communities on the benefits of adequate cooking and preparation of fish would help in reducing the disease risks.

15. The biological hazards associated with human pathogenic bacteria in products from aquaculture can be divided into two groups: (a) bacteria naturally present in the aquatic environment, referred to as the indigenous microflora, and (b) those present as a result of contamination with human or animal faeces, or otherwise introduced to the aquatic environment through human activities. Bacterial hazards may also arise through the introduction of bacteria during post-harvest handling, processing and distribution. Indigenous pathogenic bacteria, when present on fresh fish, are usually found in fairly low numbers, and where products are adequately cooked prior to consumption, food safety hazards are insignificant. During storage, indigenous spoilage bacteria will outgrow indigenous pathogenic bacteria, thus fish will spoil before becoming toxic and will be rejected by consumers. Non-indigenous bacteria of public health significance include members of the Enterobacteriaceae, such as *Salmonella* spp., *Shigella* spp., and *Escherichia coli*. In the case of *Salmonella,* various studies have indicated that although seasonal variations occur, *Salmonella* may be naturally present in some tropical aquatic environments and in some cultured fish grown in both waste-fed and non waste-fed culture ponds. Wild aquatic birds often spread these organisms and other pathogens in the environment.

16. The risk of *E. coli* infection is increased when manure, especially bovine manure known to contain pathogenic strains of these bacteria, is used as pond fertilizer. Hazards from indigenous and non-indigenous pathogens can be controlled by cooking (heating) and chilling fish sufficiently to kill the bacteria, thus avoiding post-process cross-contamination[(13, 14, 15)].

17. Molluscan shellfish harvested from inshore waters contaminated with human or animal faecal matter may harbour viruses that could be pathogenic to humans. Enteric viruses that have been implicated in seafood associated illness are the hepatitis A virus, caliciviruses, astroviruses and the Norwalk virus. All of the seafood-borne viruses causing illness are transmitted by the faecal-oral cycle and most viral gastro-enteritis outbreaks have been associated with eating contaminated shellfish, particularly raw oysters. Generally viruses are species specific and will not grow or multiply in foods or anywhere outside the host cell. There is no reliable marker for indicating presence of the virus in shellfish harvesting waters.

18. Seafood-borne viruses are difficult to detect, requiring relatively sophisticated molecular methods to identify the virus. Occurrence of viral gastro-enteritis can be minimized by controlling sewage contamination of shellfish farming areas and pre-harvest monitoring of shellfish and growing waters as well as controlling other sources of contamination during processing. Depuration or relaying are alternative strategies but longer periods are required for shellfish to purge themselves clean of viral contamination than for bacteria[(16,17,18)].

19. Several biotoxins can accumulate in the bivalve shellfish; the toxicity is due to the ingestion by the shellfish of phytoplanktonic species, which are able to synthesize toxic substances. The shellfish concentrates the toxin to a level such as it becomes potentially toxic.

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[12] Halwart, M. 2001. Fish as biocontrol agents of vectors and pests of medical and agricultural importance, pp. 70-75. In: IIRR, IDRC, FAO, NACA, and ICLARM 2001. Utilizing different aquatic resources for livelihoods in Asia: a resource book. International Institute of Rural Reconstruction, International Development Research Centre, Food and Agriculture Organization of the United Nations, Network of Aquaculture Centers in Asia-Pacific, and International Center for Living Aquatic Resources Management.
[13] FAO, 2003. Report of the twenty-fifth session of the Codex Committee on fish and fishery products. op.cit.
[14] WHO, 1999. Food safety issues associated with products from aquaculture. op.cit.
[15] M.L. Jahncke; E. Spencer Garett; Alan Reilly; Roy E. Martin and Emile Cole, 2002. op.cit.
[16] FAO, 2003. Report of the twenty-fifth session of the Codex Committee on fish and fishery products. op.cit.
[17] WHO, 1999. Food safety issues associated with products from aquaculture. op.cit.
[18] M.L. Jahncke; E. Spencer Garett; Alan Reilly; Roy E. Martin and Emile Cole, 2002. op.cit.

The principal toxins are the Paralytic Shellfish Poison (PSP) produced by dinoflagellates genus *Alexandrium*, the Diarrheic Shellfish Poison (DSP) produced by other dinoflagellates genus *Dinophysis,* Amnesic Shellfish Poisoning (ASP) in which *Nitzchi spp* produce domoic acid or Neurotoxic Shellfish Poisoning (NSP) produced by *Gymnodium spp*. All these toxins are known to keep in general their toxicity through processing, even after significant heating, so adequate monitoring of waters where shellfish intended for processing are harvested is important[19, 20, 21].

20. Potential hazards due to chemical contaminants in fish from aquaculture are[22]:

- Heavy metals
- Dioxins, dioxin-like PCBs, and other environmental pollutants
- Residues and unauthorized substances
    - Pesticides
    - Antibacterial substances (including sulphonamides)
    - Veterinary drugs other than antibiotics
    - Substances having anabolic effects on humans and other human medicines
    - Others (for instance mycotoxins, certain colour additives)

These groups include substances with maximum regulatory limits (MRL), whereas others are banned or should have no residues. MRLs are defined for authorized veterinary drugs, antibiotics, additives and certain contaminants that are already part of the environmental background.

21. Potential heavy metal hazards such as Mercury (Hg), Cadmium (Cd) and Lead (Pb) continue to be a cause of concern, among both wild and cultured fish. Proper selection of aquaculture sites and periodic monitoring of water for heavy metals should, in most aquaculture systems, assure appropriate consumer protection.

22. Dioxins are mainly a man-made hazard, caused largely by incomplete combustion of urban garbage. Long-term exposure to dioxins is linked to development of cancer and impairment of general health. An EC study estimates that about 63 percent of the total human intake of dioxins and PCBs, in terms of toxic equivalent (TEQs) correspond to fish and fish oils, even though fish and fish oils contribute only around 2.5 percent to total food intake and around one percent to the total fat intake[23]. Polychlorinated biphenyls (PCBs), also known as dioxin-like compounds, are probable human carcinogens with other detrimental health hazards. Dioxins and dioxin-like compounds bioaccumulate in cultured fish mainly from fish meal and fish oil in feeds. Improvement in the combustion of urban garbage and the ban on production of PCBs has reduced the level of contamination in developed countries. PCBs are targeted to be phased out worldwide. Their production is banned in some countries while others have adopted regulatory and/or action limits as well as environmental monitoring and control schemes.

23. Twenty polycyclic aromatic hydrocarbons (PAHs) have been found in wild and farmed salmon and salmon feeds[24]. PAHs are primarily by-products of incomplete combustion from wildfires to industrial combustion and on-road vehicles exhaust. These are suspected carcinogens which are bioaccumulative and persistent in the environment. PAHs may further increase during the process of fish smoking.

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19 FAO, 2003. Report of the twenty-fifth session of the Codex Committee on fish and fishery products. op. cit.

20 WHO, 1999. Food safety issues associated with products from aquaculture. op. cit.

21 M.L. Jahncke; E. Spencer Garett; Alan Reilly; Roy E. Martin and Emile Cole, 2002. op. cit.

22 The specific hazards discussed in this document do not constitute an exhaustive list. Not all the hazards listed are always relevant. Therefore, in each case it would be necessary to perform a detailed Hazard Analysis to identify the hazards that could be relevant.

23 European POPs Expert Team. Preparatory Actions in the Field of Dioxin and PCBs. European Commission, Brussels, Executive Summary, April 2002.

24 Easton, M.D.L.; Luszniak, D. and Von der Geest, E. Preliminary examination of contaminant loadings in farmed salmon, wild salmon and commercial salmon feed. Chemosphere 46 (2002) 1053-1074.

24. A number of pesticides are known to have detrimental effects on human health. Fish can take pesticides from water or through feed. In addition they could appear as residue of pesticides used in fish ponds. A recent study carried out in Canada on farmed and wild salmon and commercial salmon feeds found DDT (dichloro diphenyl trichloroethane) toxaphene and (aldrin) dieldrin as the most predominant pesticides, with detectable levels of a number of other organochlorine pesticides. The same study revealed that feed contamination increased the pesticide contamination of farmed salmon in comparison with wild salmon, with the exception of toxaphene[25]. Nevertheless, pesticide monitoring programmes in developed countries indicate that the actual risk from this type of hazard is rather low as shown by various studies [26] [27].

25. Antibacterial substances are utilized in aquaculture production to combat bacterial diseases[28]. There is evidence that some antibacterials are used as prophylactics and growth promotors, although it is not considered as a good management practice. The resulting hazards could be:

- presence of high levels of residues of approved antibiotics and/or residues of unapproved or banned antibiotics
- development of resistance to antibiotics in microbial pathogens in the environment.

26. The presence of residues of antimicrobials over approved MRLs could be reduced through applying good management practices, HACCP procedures, education, awareness building and working with farmers, pharmaceutical manufacturers, veterinary control authorities and other service providers. Hazards due to the use of unapproved or banned antibiotics differ depending on the type of antibiotic, dose level, national regulations, etc.; and there are no harmonized regulations yet to deal properly with this situation at the international level. Unapproved antibiotics (extra-label use of antibiotics) are used in two main situations:

- Extra label use of an approved antibiotic in aquaculture (e.g. for a species, for a period or for doses for which it has not been specifically approved). There are countries that admit this type of extra-label use, provided that it is done under the responsibility of a certified professional (e.g. a veterinarian).
- Extra-label use of an antibiotic not specifically approved for use in aquaculture (e.g. an antibiotic approved for use in humans) is acepted by some countries only if a certified professional takes this responsibility.

27. Since there are no international regulations, the use of an approved (or not regulated) antibiotic in one country may be a violation in another country. Residues of specifically banned antibiotics are a compliance violation, and it is not related to the detection level of the banned substance.

28. The release of large quantities of antibiotics into the environment, due to animal production (including aquaculture) and human use has led to the development of antibiotic resistance by pathogenic bacteria, a serious risk to human health [29, 30] . A recent study [31] "indicates that antimicrobial-resistant *Salmonella* are present in imported foods, primarily of seafood origin[32]**"**.Thirty fish species of capture and aquaculture origin were found to contain multi-resistant strains of *Salmonella*. Other authors have reported increased bacterial resistance

[25] Easton, M.D.L; Luszniak, D. and Von der Geest, op. cit.
[26] Food and Drug Administration. Pesticide Program. Residue Monitoring 2000, 24 p.
[27] Canadian Food Inspection Agency. Summary Report of Contamination Results in Fish Feed, Fish Meal and Fish Oil.
[28] FAO, Fisheries Department. The State of World Fisheries and Aquaculture 2002. Antibiotic residues in aquaculture products; pp 74-83. FAO, 2002.
[29] FDA (US) Antibiotic Resistance. A growing threat. http://www.usp.org/veterinary/monographs/chloramphenicol.pdf
[30] Antimicrobial resistance. WHO Information. Fact Sheet No 194; Revised January 2002 http://www.who.int/inf-fs/en/fact194.html
[31] Zhao, S.; Datta, A.R.; Ayers, S.; Friedman, S.; Walker, R.D. and White, D.G. Antimicrobial-resistant *Salmonella* serovars isolated from imported foods. Int. J. of Food Microbiology 2621 (2002), in press.
[32] It is necessary to keep in mind that according to US regulations *Salmonella spp* shall be absent from such products.

levels on and around fish farms related to the antimicrobials agents used at the farms. A full strategy to achieve a responsible use of antibiotics in aquaculture seems urgently needed.

29. Other veterinary drugs used in aquaculture, which are of human health concern, include anti-parasitic agents, some chemicals and steroid hormones. No international agreements exist regarding their use. Residues of malachite green MG, and its metabolite leucomalachite green LMG are suspected to be potential *in vivo* mutagens, and carcinogenic. In some countries MG is authorized for the treatment of fungal infections on fish eggs, but not on adult fish; in other countries, it is not authorized.

30. Hazards related to residues of substances having anabolic effects on humans and other medicines (for instance stilbenes and their derivatives, antithyroid agents, steroids, beta-agonists, resorcylic acid lactones) can be related to the quality of water. Large urban settlements close to aquaculture sites, coastal currents, floods, etc. could be the basis for such hazards. Therefore, appropriate selection of the site and monitoring water quality are essential.

31. The presence of mycotoxins in cultured fish could be a result of feeding with contaminated food, in particular its vegetal components. Although negligible, this risk requires further assessment.

32. Astaxanthin and canthaxanthin are two substances of the carotene chemical family that are commonly used in aquaculture feeds, as accepted colour additives. Their residues are regulated in the EU to levels considered harmeless.

## STRATEGIES TO IMPROVE SAFETY AND QUALITY OF AQUACULTURE PRODUCTS

33. There has been a growing awareness of the importance of an integrated, multidisciplinary approach to food safety and quality, considering the entire food chain. FAO defines the food chain approach as recognition that the responsibility for the supply of food that is safe, healthy and nutritious is shared along the entire food chain - by all involved with the production, processing, trade and consumption of food. Stakeholders include farmers, fishermen, food processors, transport operators, distributors, consumers, as well as governments obliged to protect public health. The holistic approach to food safety along the food chain differs from previous models in which responsibility for food safety mainly concentrated on the food processing sector and government control services. The implementation of the food chain approach requires an enabling policy and regulatory environment at national and international levels with clearly defined rules and standards, establishment of appropriate food control systems and programmes at national and local levels, and provision of appropriate training and capacity building[(33).]

34. In aquaculture, there are five broadly defined needs on which a strategy in support of a food chain approach to food safety should be based:

- Fish safety and quality from a food chain perspective should incorporate the three fundamental components of **risk analysis** - *assessment, management and communication* – and, within this analysis process, there should be an **institutional separation** of science-based risk assessment from risk management – which is the regulation and control of risk.
- **Tracing techniques** *(traceability)* from the primary producer (including animal feed and therapeutants used in the production), through post-harvest treatment, processing and distribution to the consumer must be improved.
- **Harmonization of fish quality and safety standards**, implying increased development and wider use of internationally agreed, scientifically-based standards is necessary.

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[33] FAO/WHO, 2001. Food hygiene. Basic texts. Second edition. Joint FAO/WHO Food Standards Programme. FAO, Rome.

- **Equivalence in food safety systems** – achieving similar levels of protection against fish-borne hazards and quality defects whatever means of control are used – must be further developed.
- Increased emphasis on **risk avoidance or prevention at source** within the whole food chain – *from farm or sea to plate* –, including development and dissemination of good aquaculture practices and safety and quality assurance systems (i.e. Hazard Analysis and Critical Control Point (HACCP)), are necessary to complement the traditional approach to fish safety and quality management based on regulation and control.

35. The principles of achieving harmonization of standards and equivalency in food control systems and the use of scientifically-based standards are embodied in two binding agreements of the World Trade Organization (WTO): the Agreement on the application of sanitary and phytosanitary (SPS) measures and the Agreement on technical barriers to trade (TBT). The SPS agreement confirms the right of WTO member countries to apply measures necessary to protect human, animal and plant life and health. The purpose of the SPS Agreement is to ensure that measures established by governments to protect human, animal and plant life and health, in the agricultural sector, including fisheries, are consistent with obligations prohibiting arbitrary or unjustifiable discrimination on trade between countries where the same conditions prevail and are not disguised restrictions on international trade. It requires that, with regard to food safety measures, WTO members base their national measures on international standards, guidelines and other recommendations adopted by the Codex Alimentarius Commission (CAC) where they exist. This does not prevent a member country from adopting stricter measures if there is a scientific justification for doing so or if the level of protection afforded by the Codex standard is inconsistent with the level of protection generally applied and deemed appropriate by the country concerned. The SPS Agreement states that any measures taken that conform to international Codex standards, guidelines or recommendations are deemed to be appropriate, necessary and not discriminatory. Finally, the SPS Agreement requires that SPS measures are to be based on an assessment of the risks to humans, animal and plant life using internationally accepted risk assessment techniques.

36. The objective of the TBT Agreement is to prevent the use of national or regional technical requirements, or standards in general, as unjustified technical barriers to trade. The agreement covers standards relating to all types of products including industrial products and quality requirements for foods (except requirements related to SPS measures). It includes numerous measures designed to protect the consumer against deception and economic fraud. The TBT Agreement basically provides that all technical standards and regulations must have a legitimate purpose and that the impact or cost of implementing the standard must be proportional to the purpose of the standard. It also states that, if there are two or more ways of achieving the same objective, the least trade restrictive alternative should be followed. The agreement also places emphasis on international standards, WTO members being obliged to use international standards or parts of them except where the international standard would be ineffective or inappropriate in the national situation. The aspects of food standards that TBT requirements cover specifically are quality provisions, nutritional requirements, labelling, packaging and product content regulations, and methods of analysis. Unlike the SPS Agreement, the TBT Agreement does not specifically name international standard setting bodies, whose standards are to be used as benchmarks for judging compliance with the provisions of the Agreement.

37. Risk analysis is widely recognized today as the fundamental methodology underlying the development of food safety standard that provides adequate health protection and facilitates trade in food [(34)]. There is a fundamental difference between a hazard and a risk. A hazard is a biological, chemical or physical agent in, or condition of food, with the potential to cause an adverse health effect. In contrast, risk is an estimate of the probability and severity in exposed

[34] WHO, 1995. Application of risk analysis to food standards issues. Report of the Joint FAO/WHO Expert Consultation Geneva, Switzerland 13 - 17 March 1995. WHO/FNU/FOS/95.3

populations of the adverse health effects resulting from hazard(s) in food. Risk analysis is a process consisting of three components: risk assessment, risk management and risk communication. Risk assessment is the scientific evaluation of known or potential adverse health effects resulting from human exposure to food-borne hazards**.** Risk management is the process of weighing policy alternatives to accept, minimize or reduce assessed risks and to select and implement appropriate options. Risk communication is an interactive process of exchange of information and opinion on risk among risk assessors, risk managers, and other interested parties.

38. The responsibility for the supply of fish that is safe, healthy and nutritious should be shared along the entire chain from primary production to consumption. Development and implementation of Good Aquaculture Practices (GAP), Good Hygienic Practices (GHP) and Hazard Analysis Critical Control Point (HACCP) are required in the food chain step(s). Government institutions should develop an enabling policy and a regulatory environment, organize the control services, train personnel, upgrade the control facilities and laboratories and develop national surveillance programs for relevant hazards. The support institutions (academia, trade associations, private sector, etc.) should also train personnel involved in the food chain, conduct research on quality, safety and risk assessments, and provide technical support to stakeholders. Finally, consumers and consumer advocacy groups have a counterbalancing role to ensure that safety and quality are not undermined by political considerations solely when drafting legislation or implementing safety and quality policies. They also have a major role in educating and informing the consumer about the major safety and quality issues.

39. The general principles of GHP/HACCP have been adopted by the Codex Alimentarius Commission (CAC) in 1997 and 1999 [(35)]. They include requirements for the design and facilities, control of operations (including temperature, raw materials, water supply, documentation and recall procedures), maintenance and sanitation, personal hygiene and training of personnel. Similarly, the Codex Committee on Fish and Fishery Products is working on a draft code of practice for fish and fishery products, including aquaculture products, which integrates these general principles and adapts them to aquaculture [(36)]. This Code is not intended to cover extensive fish farming systems or integrated livestock and fish culture systems that dominate production in many developing countries.

40. Control and prevention of chemical pollutants and biotoxins require the implementation of appropriate monitoring and surveillance programmes. This is particularly important for mollusc culture, filter feeders that can concentrate pollutants, biological agents, and biotoxins. The Codex Code of Practice describes the requirements for surveys and monitoring of the sites to determine sources of domestic and industrial pollution, and classification of the sites into categories such as, suitable for harvesting, relaying or non-suitable for growing or harvesting, and the frequency and methods of monitoring.

## ROLE OF FAO AND OTHER STAKEHOLDERS

41. FAO's normative work in food safety and quality is focused on food standards linked to the *Codex Alimentarius* and developed in close collaboration with the World Health Organization (WHO), and related capacity-building. *Codex Alimentarius* includes standards for all principal foods (whether processed, semi-processed or raw) for distribution to the consumer, with provisions related to food hygiene, food additives, pesticide residues, contaminants, labelling, presentation, methods of analysis and sampling. The Codex Secretariat is housed in the FAO Food and Nutrition Division (ESN), which has primary responsibility for normative work in food safety.

42. FAO in collaboration with WHO provides expert scientific advice for standard setting through Codex expert committees and/or meetings. In addition it contributes to the normative

[35] FAO/WHO, 2001. Food hygiene. Basic texts. Second edition. op. cit.
[36] FAO, 2003. Report of the twenty-fifth session of the Codex Committee on fish and fishery products. op. cit.

work of FAO, through participation in the relevant Codex committees and support to the work on risk assessment for fish and fishery products. The Fisheries Department provides direct assistance to member countries for the application of good farm management practices and the implementation of the FAO/WHO fish standards, guidelines and codes of practices. Assistance to member countries by the Fisheries Department centres around training of personnel from government authorities and the fish industry, provision of technical advice on legislation and organization of fish inspection and building national capacity in fish quality and safety research.

43. In many of the Fisheries Department's programmes, particularly within the integrated livestock-fish farming and aquatic animal health management activities, efforts are being made to provide technical assistance towards reducing the food safety risks arising from microbial contaminations and antibacterials during culture operations. Appropriate technical guidelines are being developed on GAPs, GHPs and HACCP.

44. The work on shrimp farming and environment, jointly conducted through a consortium of agencies (FAO, NACA, WWF, WB) is moving towards developing global principles on sustainable shrimp culture, which also addresses the issue of better food safety through improved farm management and culture practices.

45. Developments in international trade of aquaculture products and the accompanying concerns over their safety and quality have significantly increased the number of requests from member countries for assistance in this area and to play a more active role in the development of safety and quality standards of aquaculture fish products. To meet this unprecedented increase in the number of requests, the Fisheries Department has adapted its programme of work to the maximum possible, especially the Medium-Term Plan 2004-2009, to integrate fish safety and quality. A small trust fund project, funded by Japan, will be initiated soon, to develop technical guidelines for GAP and HACCP systems. However, significant additional resources are required to expand the technical guidelines for the application of GAP, GHP and HACCP in different aquaculture systems, to train farmers, industry and fish inspection personnel and to assist in building capacity and strengthening institutions in this area..

**SUGGESTED ACTION BY THE SUB-COMMITTEE**

46. Rapid development of aquaculture and the globalization of fish trade, while offering many benefits and opportunities, also present new safety and quality challenges. Fish safety and quality assurance in the new millennium will require enhanced levels of international cooperation in setting up standards and regulations. The SPS/TBT agreements of the WTO and the benchmarking role of the *Codex Alimentarius* Commission provide an international platform in this respect. However, in this field, developing countries are at a disadvantage because of insufficient/inadequate national capacities and resources.

47. The Sub-Committee may wish to discuss the implications of safety and quality on aquaculture fish trade, both domestically and internationally. The Sub-Committee should comment on the work of FI and recommend directions for GAP/GHP/HACCP implementation, capacity building and institution strengthening.