International Scholars Journals

Advances in Aquaculture and Fisheries Management ISSN 2756-3278 Vol. 8 (4), pp. 001-006, April, 2020. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Review

Potential hazards and risks associated with the aquaculture industry

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Accepted 16 October, 2019

Aquaculture, the farming of aquatic organisms, is fraught with potential hazards and risks which are categorized into occupational, environmental, food safety and public health. This paper reviewed major hazards and risks associated with the aquaculture industry and proffered strategies for their management and control. Aquaculture stakeholders should therefore ensure that guidelines and policies which promote an environmentally friendly and sustainable industry are instituted and enforced.

Key words: Hazards, risks, aquaculture.

INTRODUCTION

Aquaculture according to FAO (1997) is defined as 'the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants in selected or controlled environments'. Aquaculture production may have arisen as an intervention mechanism to enhance food production. It is currently one of the fastest growing food producing sectors in the world. Its global importance is related to its contribution in the reduction of the supply – demand gap of fish products. Production statistics indicate that between 1984 and 1996, there was a three fold increase in aquaculture products (FAO, 1997). The rapid growth in the aquaculture sector contrasts with the decline or near stagnation in the growth of supplies from capture fisheries. The implication is that aquaculture will continue to play an increasing role in fish supplies.

Aquaculture production can be partitioned into the formal and informal sectors of the economy. In the formal aquaculture sector, ownership of farms is corporate and well organized. The farms are large and operate under advanced technology. This is common among the developed countries such as USA, Japan, Norway and France, which contribute about 8.6% of the total global aquaculture production (WHO, 1999). The informal aquaculture, however, consists of small holder units, subsistent aquaculture practitioners and semi-organised units with low technology and infrastructure especially in the areas classified as low – income – food – deficit countries. This group is represented even in the major aquaculture producing countries such as China, India, Philippines, Indonesia and Thailand, which contribute about 80% of the global aquaculture production (FAO, 1995). Aquaculture producers from Africa also belong to this group. FAO (1997) noted that about 87.1% of the total aquaculture production was from developing countries.

Aquaculture may therefore be a veritable means of alleviating hunger as well as curbing seasonal supply of fish products. Furthermore, it has the capacity of creating jobs since labour would be expected in all the associated industries. Aquaculture is multi-faceted and also presents a diverse array of environment ranging from freshwater to marine and from simple stagnant ponds to high tech computerized closed indoor water recirculation systems. The industry is therefore, fraught with potential risks and hazards.

Johnson (2000) defined hazard as 'the presence of a material or condition that has the potential for causing loss or harm'. This implies that there is an inherent existence of threat in that system. Risk on the other hand is defined as 'a combination of the severity of consequences and likelihood of occurrence of undesired

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outcomes' (Johnson, 2000). In other words, risk is the likelihood that harm or injury from a hazard will occur to specific individuals or groups exposed to a hazard. Thus, for every system or process, there are associated risks and hazards no matter how well managed the system is.

There are inherent hazards and risks associated with aquaculture production. In developed countries there have been heated debates among stakeholders as to the risks and hazards of the system. This does not in any way preclude the importance or significance of aquaculture in the food sector. Rather it is a means of resolving issues related to the undesirable effects of the system. Unfortunately, the awareness has not been created in developing countries that produce a major proportion of the products. This is predicated on the fact that majority of the producers belong to the informal sector of the economy. Karanja et al. (2003) observed that, although this sector contributes significantly to the national economy, its semi-organised and unregulated status create a situation where workers are exposed to innumerable hazards. Thus injuries and occupational diseases, which are preventable, and food safety issues abound in such systems resulting in unnecessary loss of man hours, skilled workforce and lives. The situation is exacerbated by the fact that these farms operate outside the institutional regulatory frameworks and with minimal supervision from regulatory bodies.

This paper therefore, highlights the information on hazards and risks in aquaculture and proffers strategies for their management and control.

AQUACULTURE PRODUCTION SYSTEMS AND ANCILLARY INDUSTRIES

The associated processes in aquaculture are:

Processing: Fish products are processed and packaged for local consumption and export. The processes are carried out at the local and industrial level. These include smoking, chilling and freezing, canning, filleting and production of other value – added products.

Laboratories: These are established in research stations, large hi-tech farms and processing plants for environmental/facility water quality monitoring and quality control.

Feed mill plants: These are established to produce on farm or commercial feeds. The scale of operation is varied.

Associated industries: These are industries that are involved in manufacturing equipment used in aquaculture. These include nets, fertilizer plants, biofilter media, drugs, fibre glass tanks, etc.Finfish, shell fish and other farmed aquatic organisms are produced in freshwater, brackishwater and marine environment.

The receptacles for cultivation of these organisms include earthen ponds, pens, cages, rice fields, race ways, open water bodies, etc. Based on the level of operation, the system is classified as:

- Extensive: here no exogenous input is used and stocking density is low.
- Semi-intensive: fertilizer is applied here to augment or stimulate natural production of food organisms for the cultured organisms; stocking rate is moderate; supplementary feed is provided.
- Intensive: high density stocking rate and provision of a nutritionally complete feed.

About 70 – 80% of the total global production of farmed fin fish and crustaceans takes place within extensive and semi-intensive farming systems (FAO, 1995). In Asia, integrated farming system, in which livestock wastes are inputs in fish production and waste – water fed systems, in which domestic sewage and municipal waste water are used, are common practices.

In Africa, aquaculture is practiced in earthen ponds where livestock wastes (used in fresh or dried state) are used extensively for fertilization. In Asia, cages and pens are usually installed in highly eutrophic aquatic systems. In the earthen pond systems, polyculture of fish species is common in order to fully exploit all the feeding riches. Feeding is supplementary and usually agro by products are utilized for that purpose. However, in the developed countries, aquaculture production is based essentially on the intensive monoculture of high value fish in ponds, tanks or cages at high stocking densities and fed manufactured complete diet. Fish culture in recirculating system is becoming popular in developing countries. Here water is reused after undergoing a purification process. These farming systems have effluents which are discharged into natural water bodies or adjoining land.

HAZARDS AND RISKS

Hazards and risks related to aquaculture can be categorized into occupational, environmental and food safety and public health. Each of the different types of hazards has other components such as biological and chemical.

Occupational risks and hazards

Aquaculture industry has diverse workplaces with individual peculiarities. The hazards in aquaculture can be classified into physical, chemical and biological.

Physical: There are several physical risk factors in the aquaculture industry. Farm hands and other workers in aquafarms are susceptible to many injuries in the course of their work. The fish farmers in the informal sector are more vulnerable because according to Clarke (2002), governments in developing countries have an apathy to occupational health and safety issues. All the stakeholders – farm management, workers and governments do not appreciate the problems that can be solved or mitigated through occupational safety and health. The list of physical hazards are as follows:

- Noise: Feedmill workers (especially those that operate with locally fabricated machines in the developing countries) are exposed to excessive noise. Ojok (1995) attributed the following harmful defects to noise:- hearing defects, hearing loss and mental fatigue.
- Injuries: Farmers are exposed to diverse injuries such as:
- Sting from fish spines: This arises during fish handling without appropriate safety devices. It may cause severe pains and can result to tetanus infection or witlow.
- Cuts, sprain, fracture, etc: sharp implements/objects such as knives, oyster shells, falls and other predisposing factors can cause these injuries. Hatchery workers are also exposed to the risk of needle stick injury which can open a gateway to many viruses and other diseases.
- Occupational asthma and rhinitis: Feedmill workers are at risk of contracting these diseases. Karkkainen (2002) observed that the greatest risks occur in the foodstuffs and agricultural sectors. He attribute dust released from flour and animal feed mill as the second most common cause of asthma.
- Snake bites, crab clawing and bites from fish (such as tiger fish, snapper, etc) are hazards workers in earthen pond fish farms are exposed to, especially when they are not using appropriate protective gear. This is prevalent in rural fish farming.
- Mechanical injuries: These are associated with laboratories and processing plants.

Chemical: Aquaculture practitioners are exposed to chemical hazards through the following routes:

Constant use of chemicals: This includes inorganic fertilizers which are used extensively in enriching fish ponds. Others are lime, pesticides, formaldehyde, etc. Some of these are caustic and can cause severe burns or skin irritation resulting in severe cases of occupational dermatitis. Some laboratory chemicals are hazardous and. Inhalation may lead to development of respiratory ailments such as bronchitis, rhinitis and asthma (Uronu and Lekei, 2004). Direct contact with these chemicals could result in burns, skin irritation and allergies. It has been observed that laboratory workers that have prolonged exposure to organic solvents such as chlorinated hydrocarbons, alcohols, ester, ketone, etc. are at risk of brain and nervous system damage. The symptoms include premature ageing, memory impairement, mild depression and anxiety. Karkkainen (2002) has also attributed the following symptoms to formaldehyde poisoning: allergic dermatitis asthma and rhinitis.

- Acute and chronic pollution of water ways: Pesticides, oil spills, and other xenobiotics can pollute ponds and water sources which can also pose risks for workers that work in such farms.
- Flocculants: These are applied to ponds to precipitate suspended clay particles (WHO, 1995). Examples are aluminium sulfate (alum), calcium suilhate (gypsum).

- Disinfectants: these are used to disinfect equipment and holding units – e.g. formalin hypochlorite, etc.
- Fumes, smoke and soot: Fumes from water pumping machines feedmill and other machines; and smoke inhaled by workers smoking fish or drying feed are considered serious health risks. These are associated with asthma, cancer and other serious ailments.

Biological: These include parasitic infestation and pathogenic infections.

- Parasites: Examples include leeches in ponds which attack individuals that the wade unprotected. In developing countries where human and animal wastes are used as inputs, nematode, cestode and other parasites are hazards, farm workers are exposed to.
- Pathogens: Risk of fungal and other pathogenic infections such as vibrio has a high likelihood in intensively manured ponds. Charmish (1996) observed that individuals pricked by spines of *Tilapia* sp infected by *Vibrio vulnificus* caused amputation of fingers. Fatal cases have also been reported in NSSP operations Manual, 1992 Revision.

Environmental hazards and risks

There are a variety of risks mediated by environmental effects of aquaculture. Goldburg and Triplett (1997) divided these into four categories as follows:

Biological pollution: The introduction of non-endemic species into natural water arising from their inadvertent release from aquaculture facilities is considered a serious environmental threat. The introduced species may carry diseases and parasites alien to the native with disastrous Consequences (WHO, 1989). Instances abound where exotic fish species wiped out native stocks (Kutty, 1981). The Introduced species may have the tendency of out-competing the native stock partly because they do not have natural predators, parasites and pathogens in their new environment. This trend creates biodiversity loss in natural waters.

The introduction of genetically modified organisms such as transgenic fish is considered hazardous to the environment. Kapuscinski and Hallerman (1990) and Hallerman and Kapuscinski (1999) noted that such fish would pose ecological or genetic risks when they escape from production facilities. The authors further stated that the ecological hazards would include the possibility of the transgenic fish being a voracious predator or competitor thereby impacting negatively on key ecological processes. Inter breeding of introduced or transgenic fish with the native stock could cause dilution of the genepool. Studies by Farrell et al. (1997), Muir and Howard (1999) and Delvin et al. (1999) have highlighted considerable risk of transferring transgenic fish.

Transmission of diseases and parasites to native stocks from cage and pen facilities is a major problem. In many countries disease testing and certification programs for animals are not implemented with the result that native stocks are exposed to non endemic parasites and diseases from aquaculture facilities.

Organic pollution: The effluents from aquaculture facilities constitute significant sources of organic pollution. The effluents, which consist largely of fish and feed wastes, contain large quantities of nutrients that damage the water quality and also generate unwanted algae.

Chemical pollution: Use of chemicals in ponds and laboratories constitutes considerable risk to the environment. These chemicals can become disruptive and when they find their way into natural aquatic systems they can cause irreparable damage to the ecosystem. Chemicals such as fertilizers, pesticides, antifoulants (for cages), chemotherapeutants are all considered risk factors in the environment.

Habitat modification: Aquaculture sites negatively impact the environment. Aquaculture development can sometimes change landscapes of aquatic systems resulting in habitat destruction and loss of biodiversity. The newly created habitat may not be able to sustain the natural ecological balance.

Food safety and public health hazards

Aquaculture products like other foods have hazards that may adversely affect the consumers' health. The production system also presents risks to public health. The major health risks of aquaculture products are biological especially for the organisms produced in waste water or water receiving animal and human wastes. Edward (2001) noted that the pathogenic, enterobacteria (from the human digestive tract), have been found in fish guts. This, therefore, raises the question of the safety of consuming fish products from such environments. Food-borne trematodes such as *Clonorchis sinensis* and *Opisthorchis viverrini* are known to cause diseases particularly among Asians that eat their fish raw or poorly cooked. Enteric diseases caused by trematode parasites have been reported in Egypt and Republic of Korea (WHO, 1999). Fish borne nematodiases have also been reported as incidental infections.

There are hazards associated with human pathogenic bacteria in finfish and crustaceans. These bacteria are partly the indigenous flora and partly a consequence of contamination through human or animal waste (Buras, 1993). Other sources of contamination include post-harvest handling and processing. Aquatic microorganisms such as algae and detritus produce toxic compounds, which can present significant human health risks. A good example is the dinoflgellate, *Alexandrium tamarensis*, which causes toxic red tide (Buras, 1993). Humans that consume shellfish (lobster and crabs) that have ingested this organism stand the risk of being afflicted with paralytic shellfish poisoning (Price, 1997). Shellfish have also been implicated as vectors of human pathogens such as vibrio bacterium which is a causative organism of human gastroenteritis. Filter feeders such as clams, mussels and oysters, which accumulate contaminants in their internal organs, also present potential threat to the health of consumers. Ahmed (1991) and Hackney and Pierson (1994) reported that the greatest number of seafood – associated illnesses are from consumption of raw molluscs harvested in waters contaminated with raw or poorly treated human sewage.

Some chemical products used in aquaculture are considered hazardous in terms of food safety. These include chemical fertilizers, lime, flocculants, algicides, disinfectants and chemotherapeutants. Some of these compounds may be biomagnified in the animal tissue and so consumers are at risk of intoxication with the chemicals. Other chemicals may be released from other sources e.g. industrial hydrocarbons and thus pollute aquaculture water source. This is more pronounced in urban aquaculture where waste water is reused. WHO (1999) recommended that fish raised in contaminated water should be considered as risk.

Other hazards of public health interest include proliferation of mosquito larvae and cercaria which increase the incidence and prevalence of malaria and filariasis, respectively. This is more common in developing countries where numerous small fish impoundments are constructed thus promoting higher densities of these organisms (Mott, 1996). Food contamination by residues of antibiotics and veterinary drugs is also considered a hazard. Furthermore, antibiotic resistance has been reported in areas where farmed aquatic animals are receiving treatment. Angulo

(2000) reported that the use of antibiotics by the Ecuadorian shrimp farming industry caused the development of multidrug resistant *Vibro cholera*. Humans infected by such antibiotic – resistant organisms would find treatment complicated. The contentious issue of the safety of genetically modified fish is worth looking at. Transgenic fish have been classified as hazardous in terms of food safety because of their potential allergenicity and toxicity (Hallerman and Kapuscinski, 1999). These claims, however, need to be validated. In addition introduction of pathogenic organisms during processing of products under unhygienic conditions is also of public health importance.

STRATEGIES FOR MANAGEMENT AND CONTROL OF HAZARDS AND RISKS IN AQUACULTURE

The principles for controlling hazards in aquaculture will include the identification of hazard, control of the hazard and monitoring of the effectiveness of the controls. This paper has identified the risk factors and hazards in the section above. In this section, control measures to reduce or minimize aquaculture risks would be proffered. As stated earlier, ignorance on the part of workers and the apathy of employers and government agencies to their plight have caused preventable fatalities.

Production of safe foods from aquaculture is, therefore, the shared responsibility of governments, industry and consumers, each having an important role to play in the protection of human health. Action at all levels is required for the development of regulations and the provision of resources for enforcement of, education and training in, and research on, responsible practices of aquaculture. We recommend as follows:

- On employment, workers should be well-instructed and trained on the associated risks and hazards of their vocation. There should be a re-orientation of old staff so as to inculcate safety consciousness.
- Personal protective gear should be provided for all categories of staff. The use of such gear should be strictly enforced to reduce risks of accidents or other workplace hazards.
- Laboratory workers and other staff using chemicals should be subjected to regular medical checks for early detection of any adverse impact of chemical intoxication.
- There should be the provision of first aid kits at all aquaculture facilities and adequate instructions on their usage.
- Proper records of aquaculture – related hazards should be kept (and updated) so as to create awareness of the existence of such. This will serve as an advance preventive or precautionary measure.
- Specialist occupational medical clinical service with
- Specialist occupational medical clinical service with access to specialized diagnostic and management resource should be established. This service would provide diagnosis and management of occupational diseases and would also serve as quick intervention.
- Governments need to put in place proactive policies and legislation that will envisage problem and institute preventive measures. Enforcement of these measures is imperative.
- Guidelines should be provided by relevant stakeholders on how to achieve a basic level of environmental protection within the vicinity of aqua farms.
- Countries should adopt the Hazard Analysis Critical Control Point (HACCP) framework (Reilly and Kaeferstein, 1997) which is an innovation intended to improve food safety.
- To develop appropriate food safety controls, a proper understanding of the association between reduction in hazards associated with food and reduction in risk to consumers is of central importance.
- An integrated approach involving the health education, vector control and selective population chemotherapy should be adopted to address parasite problems.
- Indiscriminate and unregulated use of chemicals and therapeutics should be discouraged so as to protect theecosystemandpublichealth.

CONCLUSION

Hazards and risks have the potential of affecting people and all human activities have this inherent capacity. Aquaculture is no exception. However, available information is largely on hazards and risks in developed countries. Unfortunately, in the developing countries where 87% of the global aquaculture production takes place both workers, employers, government and consumers have tended to ignore policies (where present), which could ensure safe aquaculture practice. In some countries policies to ensure the enforcement of regulatory standards have not been instituted. This has resulted in unregulated aquaculture with the attendant adverse impact.

It is our view that aquaculture stakeholders should work in unison to provide guideline and policies that would promote an environmentally friendly and sustainable industry.

REFERENCES

Ahmed FE (ed.) (1991) Seafood safety. Committee on the evaluation of the safety of fishery products, food and Nutrition Board, Institute of medicine. Washington National Academy Press. p. 474.

Angulo F (2000) Antimicrobial agents in aquaculture: Potential impacts on public health. APUA Newsletter 18(1): 1-6.

Buras N (1993) Microbial safety of produce from wastewater-fed aquaculture. pp. 285-295. In: Proceeding of a Conference on Environment and Aquaculture in Developing Countries, Bellagio, Italy, September 1990. Manila, Philippines: International Centre for Living Aquatic Resources Management.

Charmish B (1996). Vibrio hits Israel; tilapia sales. Fish Farmer, 10 (5): 17.

Clarke EEK (2002). Multidisciplinary occupational health services. Afr. Newsletter Occup. Health and Safety 14 (1): 3.

Delvin RH, Johnson JI, Smailus DE, Biagi CA.,Johnsson E , Bjornsson BT (1999) Increased abilty to compete for food by growth hormone transgenic coho salmon (*Oncxorhynchus* Kisutch Walbaum). Res., 30:1–4.

Edwards, P. (2001). Aquaculture. In: UNEP International sourcs book on environmentally sound technologies for wastewater and stormwater management (Osaka: United Nations Environmental Programme, International Environmental Technology Centre)

Hallerman EM, Kapuscinski AR (1999). Ecological implications of using transgenic fishes in aquaculture. International Council for the Exploration of the Seas Marine science Symposia 194: 56 – 66.

Johnson RW (2000). Risk management by risk magnitudes – Unwin Company Integrated Risk Management. pp. 1 – 2.

Kapuscinski A R Hallerman EM (1990). Transgenic fish and public policy. Anticipating environmental impacts of transgenic fisheries. Fisheries 15 (1): 2-11.

Karanja IWM, Muchiri FK, Muruka A (2003). Safety and health in the informal economy. Afr. News letter. Occup. Health and Safety. 13(1): 4-6.

Karkkainen E (2002). When work becomes a wheeze. World health safety. p.12.

Kutty MN (1981). Introduction of exotic species. Lecture notes presented to M.Sc. Students.

Muir WM, Howard RD (1999). Possible ecological risks of transgenic organism release when transgenes affect mating success: Sexual selection and the Trojan gene hypothesis. Proc. Natl. Acad. Sci. USA 96: 13853-13856.

Mott KE (1996). A proposed national plan of action for schistosomiasis control in the United Republic of Cameroun. Geneva: World Health Organisation. WHO/SCHISTO/86, 88.

Ojok JRM (1995). Methods of noise control. Afr. Newslett. Occup. Health and safety 5(1): 10-11.

Price R J (1997). Compendium of fish and fishery product processing methods, hazards and controls. Davis, CA, National Seafood HACCP Alliance for Training and Education, University of California, 1997.

Reilly A, F Kaferstein (1997). Food safety hazards and the application of the principles of the hazard analysis and critical control point (HACCP) system for their control in aquaculture production. Aquacult. Res. 28: 735-752.

Uronu AB, Lekei EE (2004). Health hazards for plant quarantine and pesticide infestors in Tanzania. Afr. Newslett. Occup. Health and Safety 14(1): 7-9.

WHO Scientific Group (1989). Health guidelines for the use of waste water in agriculture and aquaculture. World Health Organisation Technical reports series no. 776. WHO Scientific Group, World Health Organisation (WHO), Geneva, Switzerland.

WHO (1999). Control of foodborne trematode infections. Report of a WHO Study Group. Geneva, World Health Organization, 1995. WHO Technical Report Series, No. 849.

WHO (1999) Food safety issues associated with products from aquaculture. Report of a Joint FAO/NACA/WHO study group WHO Technical Report Series 883. Geneva: WHO.