The Use of Chemicals in Aquaculture in Indonesia

Hambali Supriyadi and Akhmad Rukyani

Research Institute for Freshwater Fisheries
Sukamandi, West Java, Indonesia

ABSTRACT

Aquaculture systems in Indonesia have developed toward intensive culture. As a result of intensification of fish culture, increased outbreaks of disease have occurred. Various chemotherapeutic agents like antibiotics and other chemicals have been widely used for treatment and prevention of infectious diseases in fish and shrimp farms. Antibiotics such as oxytetracycline, chloramphenicol, neomycin, streptomycin, erythromycin, prefuran and enrofloxacin are used in the treatment of bacterial diseases. Other chemicals such as malachite green oxalate, potassium permanganate, formalin, methylene blue, chlorine and teaseed have been used for the treatment of various diseases. Organic fertilizers, such as chicken manure, and inorganic fertilizers like urea and trisodium phosphate are often applied by shrimp farmers to improve primary productivity in ponds. Bacterial products with trade names like "Multi bacter," "Enviro star" and "Super NB" have recently been used by shrimp farmers to decompose organic matter resulting from excessive feeding. Feed additives such as vitamin C, "Protec Plus," and "Super Embak" are used for disease prevention.

INTRODUCTION

Fish is the primary source of animal protein in Indonesia. The biggest source of fish in the market is marine and freshwater capture fisheries, while aquaculture accounted for 12.7% of the total fish production in 1985 (Rahardjo 1987).

Aquaculture systems have developed toward intensive culture. However, intensification of fish culture has resulted in increased outbreaks of fish disease. Outbreaks of disease caused great damage to carp production in late 1980 in West Java, where a total of 1,250 t of carp, with an estimated value of US$ two million, was lost (Djajadiredja *et al.* 1983, Dana 1987). Important bacterial pathogens in freshwater fish culture include *Aeromonas hydrophila*, *Pseudomonas* spp. and *Flexibacter columnaris* (Supriyadi and Rukyani 1992).

Indonesia is one of the principal shrimp producers in the world, together with Thailand, Ecuador, India and The People's Republic of China (Rosenberry 1993, Born *et al.* 1994). Until the early 1980s, shrimp were grown in extensive pond systems, but in 1984 intensive culture was introduced to East Java. Since then the production of shrimp in East Java increased. However, from 1992 onwards the production per hectare has decreased dramatically. Figures presented by Rosenberry (1991, 1993) indicate a drop in harvest from 140,000 mt in 1991 to 80,000 mt in 1993 for the whole of Indonesia. Reasons for this decline in shrimp production remain unclear, although it is suspected that both infectious and non-infectious diseases may play a major role.

The primary constraint to successful fish farming in Indonesia is poor water management, as evidenced by increased disease occurrence. Infectious diseases and other health problems are often the result of environmental disfunction. Various species of *Vibrio* are implicated in vibriosis in shrimp pond-culture and in shrimp hatcheries. Similarly, these pathogens are causing disease in cultured marine fish , especially in cages (Supriyadi and Rukyani 1992).

Some antibiotics and chemicals have been successfully used to treat fish diseases. Antibiotics became very important and were frequently used for the treatment of bacterial diseases, especially in shrimp hatcheries. Similarly, formalin has been used to eradicate protozoan and crustacean fish parasites.

This paper presents the status of chemical usage in fish and shrimp culture in Indonesia and is largely based upon information collected from freshwater fish culture and shrimp culture facilities on the islands of Java and Sumatra.

THE USE OF CHEMICALS IN AQUACULTURE

Advantages of Chemical Use

Health problems have become very common in fish and shrimp culture, especially in intensive systems. Protozoan and crustacean ectoparasites, as well as bacterial diseases caused by *Aeromonas hydrophila* and *Vibrio* spp. account for significant mortality in freshwater fish culture and brackishwater shrimp culture. *Vibrio harveyi* has been reported to cause mass mortalities in both grow-out ponds and hatchery facilities of black tiger shrimp in West, Central and East Java. To overcome these problems, various chemotherapeutic agents including antibiotics and other chemicals have been widely used for treatment and prevention of infectious diseases in fish and shrimp farms. The application of chemicals by immersion and the addition of antibiotics to fish feed are the methods that are normally practiced by the farmers.

Antibiotics and Other Chemotherapeutants Used in Indonesia

The antibiotics that are usually applied to treat bacterial fish and shrimp diseases are mostly derived from human medicine, poultry science, and other branches of animal medicine. There are no antibiotics developed specifically for the purpose of treating bacterial disease of fish. Many antibiotics can be bought from local suppliers, drug stores and poultry shops. Table 1 lists some antibiotics and their usage. Oxytetracycline or terramycin is used widely for treatment of bacterial fish and shrimp diseases. Chloramphenicol, erythromycin, streptomycin, prefuran and neomycin are also used in the treatment of bacterial disease in shrimp and ornamental fish. Enrofloxacin (a derivative of quinolone), has recently been used as an antibacterial agent in food and ornamental fish culture.

Table 1. List of antibiotics and their usage in aquaculture in Indonesia.

Name of Antibiotic	Route of Administration	Dose
Oxytetracycline	Bath	5-10 ppm
	Oral	50 mg/kg/d, 7-10 d
Chloramphenicol	Immersion	5 ppm
Erythromycin	Bath	4 ppm
Streptomycin	Long bath	4 ppm
Prefuran	Immersion	1 ppm
Enrofloxacin	Bath	5-10 ppm
Neomycin	Bath	4 ppm

Antibiotic application has resulted in some negative effects. The emergence of drug-resistant bacteria has made treatment with some antibiotics difficult and ineffective. The detection of antibiotic residues in exported fish products coming from Indonesian farms has resulted in rejection by the Japanese market.

Other chemotherapeutants being used are listed in Table 2. Formalin, malachite green oxalate, potassium permanganate, methylene blue, chlorine and teaseed preparations have been used to treat various diseases and to eliminate unwanted fish that act as competitors in the ponds. These chemicals are available from chemical companies and in agricultural chemical stores or poultry shops.

Table 2. List of chemicals used in aquaculture in Indonesia.

Name of Chemical	Route of Administration	Dose
Formalin	Immersion	25 ppm
Malachite green oxalate	Immersion	0.15 ppm
Potassium permanganate	Immersion	40 ppm
Methylene blue	Immersion	1-2 ppm
Chlorine	Immersion	60 ppm
Teaseed	Long bath	10 ppm
Brestan	Long bath	0.5-1.0 ppm
Thiodan	Long bath	10 cc/ha
Fertilizers		
Chicken manure	Spreading	500 kg/ha
Urea	Spreading	50-70 kg/ha
Trisodium phosphate	Spreading	35 kg/ha
Organic Matter Decomposers		
Multi bacter	Spreading	no data
Enviro star	Spreading	no data
Super NB	Spreading	no data
Feed Additives		
C-vitamin	Oral	150-200 mg/kg
Protec plus	Oral	3-5 gm/kg feed/d
Super embak	Oral	2-4 gm/kg feed/d

Formalin and malachite green oxalate are widely used for the control of fish and shrimp diseases caused by fungi and protozoan and crustacean parasites. Potassium permanganate is used as a disinfectant. Methylene blue is used as treatment against protozoans and as a fungicide. Teaseed preparations are frequently used during pond preparation to eradicate fish species which act as competitors during culture.

Organic fertilizers such as chicken manure, and inorganic fertilizers like urea and trisodium phosphate are often applied by shrimp farmers to enhance primary productivity in ponds. Organic matter decomposers such as bacterial products with trade names like "Multi bacter," "Enviro star" and "Super NB" have recently become available in Indonesia and are used by shrimp farmers. These bacterial products are said to contain *Bacillus*, *Pseudomonas* sp., *Nitrobacter* sp., *Nitrosomonas* sp. and *Acinetobacter* sp. Feed additives such as vitamin C, "Protec Plus" and "Super Embak" are also used in shrimp culture to enhance the nutritional value of artificial feed pellets.

Government regulations made by the Directorate General of Fisheries suggest that a withdrawal period of at least two weeks be observed prior to the harvest of treated fish. These regulations also state that treated water should not be disposed into water bodies that are normally used for human activity.

FARM MANAGEMENT PRACTICES

Antibiotics and chemicals have been applied in farms for treatment and prevention of fish diseases. Oxytetracycline or terramycin (Pfizer) is used widely for treatment of bacterial diseases of food and aquarium fishes. The antibiotics are applied either as 5-10 ppm baths for 24 h, or incorporated into feeds at 50 mg/kg body weight /d, given continuously for 7-10 d.

Chloramphenicol at 5 ppm is also used as bath treatment for bacterial diseases of shrimp and ornamental fish. Application of erythromycin at 4 ppm by bath is practiced by farmers to control bacterial disease of shrimp. Streptomycin at 4 ppm is also used, especially in shrimp hatcheries as a long bath treatment. Application of 1 ppm prefuran is practiced to control bacterial diseases in shrimp hatcheries and freshwater ornamental fish culture. Enrofloxacin at a dose of 5-10 ppm was recently used as an antibacterial agent in fish and ornamental fish culture. Neomycin at a dose of 4 ppm is used to treat bacterial disease in shrimp hatcheries.

Formalin at 25 ppm is widely used for the control of fish and shrimp diseases caused by protozoan and crustacean parasites. Formalin at 25 ppm combined with malachite green oxalate at 0.15 ppm is normally used for the treatment of white spot (*Ichthyophthirius multifiliis*) on fish. The treatment is usually repeated three times at 3-d intervals.

Malachite green oxalate at 0.15 ppm is still being used to treat mycosis in fish and shrimp hatcheries. Potassium permanganate at 40 ppm is used as a disinfectant, but at 20 ppm, it is used as a long bath treatment against bacterial disease. Methylene blue at a dose of 1-2 ppm is used as an indefinite bath against protozoans and fungi.

Chlorine at 60 ppm is used to disinfect hatchery paraphernalia and to decontaminate shrimp hatchery facilities.

During the preparation of grow-out shrimp ponds, teaseed at 10 ppm is frequently used to control competitors. The molluscicides Brestan 50 EC, applied at 0.5-1.0 ppm, and Thiodan, applied at 10 cc/ha (at a water level of 5-10 cm) have also been used during pond preparation to eradicate snails considered as pests in black tiger shrimp ponds. However, both pesticides are now banned by the government for use in grow-out ponds.

Application of lime is done by shrimp farmers to condition the soil and to eradicate pathogens. Lime is also applied in freshwater fish farms for the same reasons. Liquid "Primadin" has also been used by some shrimp farmers as a disinfectant (4.0-6.0 ppm) or for disease prevention (0.5-1.0 ppm). Rivanol is a disinfectant being used in shrimp hatcheries.

ALTERNATIVE DISEASE PREVENTION METHODS

The goverment and fish farmers have realized that the use of chemotherapeutic agents in aquaculture sometimes leads to environmental deterioration and contributes to the development of drug-resistant strains of bacteria. Alternative disease prevention methods have been directed toward appropriate farm management methods, such as the control of water quality. Water quality improvement by using organic matter-decomposing bacteria has been practiced, especially by shrimp farmers in Java and South Sumatra. Biofilters have also been used, but their usage is confined to freshwater fish hatcheries and ornamental fish culture systems.

Disease problems are usually associated with intensive culture systems. The higher the stocking density, the more often disease outbreaks occur. To minimize disease occurrence, the farmers, especially those on Java, have tried to reduce stocking density. This approach was largely based on the carrying capacity of the pond.

Vaccination was recently introduced to prevent bacterial diseases. *Vibrio* vaccine used for preventing vibriosis in marine and coastal aquaculture, and *Aeromonas* vaccine used against *A. hydrophila* in freshwater fish culture have been developed.

The use of vitamin C at 150-500 mg/kg feed was initiated by a government-owned shrimp pond in East Java with encouraging results.

NATIONAL REGULATIONS ON THE USE OF CHEMICALS IN AQUACULTURE

There is no government agency that regulates the use of chemicals in aquaculture in Indonesia. However, regulations have been formulated by the Committee on Drugs for Animal Husbandry, under the Directorate General of Animal Husbandry. The fisheries sector is represented on this committee by fisheries scientists, particularly those from the Research Institute for Freshwater Fisheries (RIFF). The committee was formed through the Ministry of Agriculture's Decree No. 476/Kpts/OP/7/1978, which was updated by No. 300/Kpts/OP/5/1982, concerning the environmental management and environmental impact analysis regulated by Government Act No. 4, 1982 and Government Regulation No. 29, 1986.

Pesticide usage, storage and distribution are regulated by Presidential Decree No. 7, 1980. The Pesticide Commission regulates and screens pesticides that will be distributed and marketed for agricultural purposes. A fishery sector representative to this committee also comes from RIFF.

Aquaculture feeds, as well as feed additives like growth promoters, hormones, and probiotics, are governed by Ministry of Industry Decree No. 37, 1992.

ON-GOING RESEARCH ON CHEMICAL USE FOR AQUACULTURE

As was mentioned above, scientists from RIFF sit as members of the Pesticide Committee. RIFF routinely conducts research on the toxicity of pesticides that will be marketed and used in rice paddy fields. Research on the acute and chronic toxicity of the pesticides endosulphan, chlorpiriphos and chlorfluozuron against fish, shrimp and zooplankton is also being conducted. The persistence and accumulation of these pesticides in fish, shrimp and zooplankton, and their role as immunosupressors in fish are also being studied.

The level of the antibiotics enrofloxacin, chloramphenicol and oxytetracycline in fish blood after immersion in different concentration has been studied. Research on the use of immunostimulatory substances (glucans) in *Clarias batrachus* has also been conducted.

CONCLUSIONS

Chemicals such as antibiotics are important chemotherapeutic agents; however, their indiscriminate use will lead to environmental problems such as the development of drug-resistant strains of microorganisms. The formulation of appropriate regulations and guidelines on the use of chemotherapeutic agents is needed. The benefits and risks of chemical use in aquaculture need to be intensively studied.

The improvement of water quality, and the use of immunostimulants, vaccines, and high quality fish feeds are the best approaches to disease prevention. The use of biological filters and the application of organic matter-decomposing bacteria are advisable for the improvement of water quality.

REFERENCES

Born AF, Verdegem MCJ, Huismana EA. 1994. Macroeconomic factors influencing world aquaculture production. Aquacult. Fish. Manag. 25:519-536.

Dana D. 1987. Current fish health problems in Indonesia. In: Arthur JR. ed. Fish Quarantine and Fish Diseases in South and Southeast Asia: 1986 Update. p. 9-11. Asian Fish. Soc. Spec. Publ. No. 1.

Djajadiredja R, Panjaitan TH, Rukyani A, Sarono A, Satyani D, Supriyadi H. 1983. Country report. Indonesia. In: Davy FB, Chouinard A. eds. Fish Quarantine and Fish Diseases in Southeast Asia. Report of a Workshop held in Jakarta, Indonesia, 7-10 December 1982. p. 19-30. Intern. Develop. Res. Centre Publ. IDRC-210e, Ottawa.

Rahardjo K. 1987. Fisheries Statistics of Indonesia (Statistik Perikanan Indonesia). Direktorat Jenderal Perikanan, Departemen Pertanian Jakarta. 136 p. (in Bahasa Indonesia).

Rosenberry B. 1991. World Shrimp Farming 1991. San Diego, CA.

Rosenberry B. 1993. World Shrimp Farming 1993. San Diego, CA.

Supriyadi H, Rukyani A. 1992. The use of chemotherapeutic agents for the treatment of bacterial diseases of fish and shrimp in Indonesia. In: Shariff M, Subsinghe RP, Arthur JR. eds. Diseases in Asian Aquaculture. p. 515-517. Fish Health Section, Asian Fisheries Society, Manila.