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Current Status on the Use of Chemicals and Biological Products and Health Management Practices in Aquaculture Farms in the Philippines

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Abstract

In the early and mid-1990s in the Philippines, more than 100 chemicals and biological products are used in aquaculture from pond preparation to culture period and for disease prevention and control. The present study documents through a nationwide survey the current status of use of chemicals and other biological products in milkfish *Chanos chanos* and black tiger shrimp *Penaeus monodon* brackish water farms in relation to aquatic health management. The results of the farm survey show that chemical usage especially in shrimp culture is minimized. Antibiotics are no longer part of disease control program and have been replaced by environment-friendly measures. Current approaches to disease intervention are geared towards prevention rather than treatment.

Aquaculture in the Philippines yields largely milkfish *Chanos chanos* and black tiger shrimp *Penaeus monodon*. In 2005, milkfish and shrimp production from brackish water ponds alone were 210,652 and 37,720 metric tons, respectively (Table 1). Milkfish production is concentrated in Regions 1, 3 and 6 in Northern and Central Luzon, and Western Visayas while shrimp is concentrated in Regions 3, 9 and 10 in Central Luzon, and Western and Northern Mindanao (Table 1).

The practice of traditional polyculture and extensive monoculture did not pose major problems. However, when culture system shifted to semi-intensive and intensive systems, stocking densities were increased and formulated feeds were used.[1)] Management of water quality and maintenance of the culture environment became difficult, while cultured species became more susceptible to disease.

Table 1. Milkfish and black tiger shrimp 2005 production (in metric ton) from brackish water fishponds in the Philippines by region.*

Region	Milkfish	Tiger shrimp	Total
NCR	415.7	2.5	418.2
1	20,379.3	174.8	20,544.1
2	310.8	123.2	434.0
3	58,804.8	16,646.8	75,451.6
4-A	14,930.3	1,173.4	16,103.7
4-B	3,866.3	663.8	4,530.1
5	1,755.4	453.5	2,208.9
6	66,249.0	716.2	66,965.2
7	6,528.1	1,718.1	8,246.2
8	3,072.3	361.7	3,434.0
9	11,141.0	7,103.4	18,244.4
10	7,984.4	6,158.5	14,142.9
11	4,978.9	140.4	5,119.3
12	6,891.6	546.2	7,437.8
13	1,407.3	1,533.7	2,941.0
ARMM	2,435.7	203.8	2,639.5
Total	267,596.7	37,720.0	305,316.6

* http://www.bfar.gov.ph
NCR, National Capital Region
ARMM, Autonomous Region in Muslim Mindanao

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The intensification of aquaculture resulted to frequent occurrence of several infectious diseases, and consequently the use of chemicals and biological products has become inevitable.[2, 3] A survey conducted in the Philippines in early and mid-1990s showed the use of more than 100 products during pond preparation, culture period and for disease prevention and control.[4, 5]

The present study documents through a nationwide survey the current practices in milkfish and tiger shrimp brackish water farms in relation to aquatic health management. It covers the chemicals and biological products used for the past 5 years during the entire culture period, from preparation of facilities up to harvest time. Disease problems encountered and current approaches to disease prevention and control were also included in the survey. Results of the present study may serve as baseline data in the government's current national effort to mitigate the negative impact of aquaculture and maintain its sustainability.

Materials and Methods

A nationwide survey among milkfish and shrimp brackish water fishponds was undertaken in September to November 2006 and February to March 2007. A questionnaire was developed to obtain a comprehensive database on the following: farm characteristics and practices; chemicals and biological products used for the past 5 years during pond preparation, culture period and for disease prevention and control; disease problems encountered for the past 5 years; and measures implemented for disease prevention and control. All surveys were done on site and farm technicians, managers, owners and technical consultants were interviewed during these visits.

Results

A total of 39 milkfish (Luzon, 18; Visayas, 14; Mindanao, 7) and 40 shrimp (Luzon, 5; Visayas, 25; Mindanao, 10) monoculture, and 21 shrimp-milkfish polyculture (Luzon, 13; Visayas, 4; Mindanao, 4) farms are included in the survey (Fig. 1).

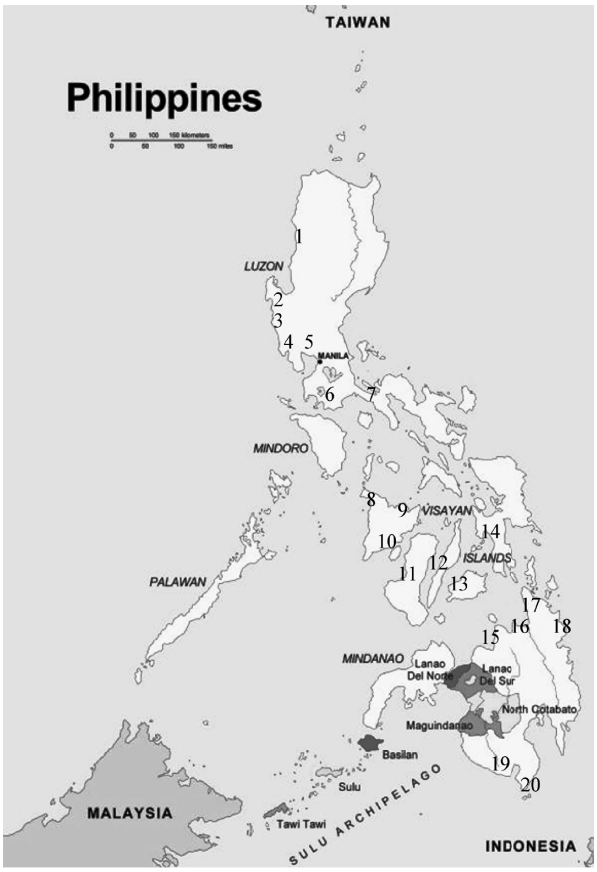

Fig. 1. Map of the Philippines showing the location of the milkfish and black tiger shrimp brackish water farms included in the September 2006 to March 2007 survey on use of chemicals and biological products in aquaculture. Luzon area: 1, La Union; 2, Pangasinan; 3, Zambales; 4, Pampanga; 5, Bulacan; 6, Batangas; 7, Quezon; Visayas area: 8, Aklan; 9, Capiz; 10, Iloilo; 11, Negros Occidental; 12, Cebu; 13, Bohol; 14, Leyte; Mindanao area: 15, Misamis Oriental; 16, Agusan del Norte; 17, Surigao del Norte; 18, Surigao del Sur; 19, Sarangani; 20, Davao del Sur.
(modified from: http://selfdetermine.irconline.org/conflicts/maps/philippines.jpg)

1. Milkfish Monoculture Farms

For milkfish monoculture, farm area range is 1-180 ha with majority having 1-20 ha (49%) while the rest with 21-40 ha (23%) and > 40 ha (28%). Milkfish fry are obtained either from the wild (48%) or hatchery-

bred (52%). Stocking density during the nursery phase ranges between 10-100 /m^2 with supplemental food in the form of fry mash given at 10-15% body weight for 2-4x/day. Culture period in the nursery stage is 45-60 days. In the grow-out phase, farmers shift to the traditional practice of ≤1 /m^2 with "lablab" as the main natural food. Culture period is 3-4 months. Production ranges from 1-5 t/ha.

2. Shrimp Monoculture Farms

Area of shrimp monoculture farms is from 1-60 ha with majority having an area of 1-20 ha (70%), the rest with 21-40 ha (20%) and >40 ha (10%). All shrimp farms obtain their fry from hatcheries. Stocking density ranges from 10-50 /m^2 (1-10 /m^2, 15%; 11-20 /m^2, 43%; 21-30 /m^2, 20%; >30 /m^2, 22%) with artificial feeds given at 6-8% of body weight for 5-6x/day during the first half of the culture period and reduced to 2-3% of body weight for 6-7x/day during the latter half. Culture period is 4-6 months. The survival rate is 40-100% with a production of 3-10 t/ha.

3. Shrimp-Milkfish Polyculture Farms

The shrimp-milkfish poly-culture farm area ranges from 1.5-105 ha with majority having an area of 1-20 ha (57%), the rest with 21-40 ha (24%) and >40 ha (19%). Stocking density for shrimps is 1-22 /m^2 (1-10 /m^2, 76%; 11-20 /m^2, 14%; ≥21 /m^2, 10%) and ≤1 /m^2 for milkfish. Artificial feeds are given at 2-3x/day as a supplement to natural food. Survival rate is 10-95% with a production of 1-12 t.

4. Chemicals and Biological Products

To provide a pond bottom suitable for growth of natural food and a pond environment with appropriate stable water quality and free from pests and predators, various chemicals and biological products are added to pond soil and water or incorporated in feeds. These products are summarized based on their mode of action and purpose in Tables 2 to 7. The amounts applied vary from farm to farm, and are usually based on experience, available published literature, or upon the recommendation of the technical consultant or the product's supplier.

4.1. Soil and water conditioners

Lime is applied to make the pond soil pH neutral or alkaline and to enhance volatilization of ammonia. It is also considered as a disinfectant. Lime is broadcast by hand during pond preparation phase, on dried and cracked pond bottom, sides and dikes. In shrimp culture, lime is also applied during the rearing phase. The farm survey showed that the most commonly used lime is agricultural lime ($CaCO_3$), followed by hydrated lime ($Ca(OH)_2$) and dolomite ($MgCO_3$) (Table 2). Generally, hydrated lime is applied to new ponds during the first year of operation and on soil with very low pH (pH ≤ 5). Agricultural lime is applied to old ponds. Sugar or molasses is applied to eliminate the growth of sucrose-forming *Vibrio* spp.

Table 2. Soil and water conditioners used during pond preparation in milkfish and black tiger shrimp brackish water farms in the Philippines. Amount in parentheses are percentage of users.

Chemical	Milkfish (n=39)	Shrimp (n=40)	Polyculture (n=21)
Agricultural lime($CaCO_3$)	0.2-6 t/ha (49%)	1-10 t/ha (88%) 200-300 kg/ha*	1-5 t/ha (81%) 140-400 kg/ha*
Hydrated lime ($Ca(OH)_2$)	0.2-2 t/ha (28%)	0.4-2 t/ha (63%) 50-200 kg/ha*	0.75-1.5 t/ha (43%) 200-300 kg/ha*
Dolomite ($MgCO_3$)	40-600 kg/ha (8%)	100-200 kg/ha/wk (13%)	250 kg/ha (5%)
Sugar/molasses	-	20-30 kg/ha (10%)	20 kg/ha (5%)

*amount applied during rearing phase; n = number of farms surveyed

Table 3. Organic and inorganic fertilizers used during pond preparation in milkfish and black tiger shrimp brackish water farms in the Philippines. Amount in parentheses are percentage of users.

Fertilizer	Milkfish (n=39)	Shrimp (n=40)	Polyculture (n=21)
Chicken manure	1-10 t/ha (85%);0.1-1.5 t/ha*	-	0.5-10 t/ha (52%)
Cow/carabao manure	2.5 t/ha (3%)	50-250 kg/ha (13%)	-
Mud press (sugar mill)	6 t/ha (3%)	-	-
Horse manure	-	16 kg/ha (3%)	-
Pig manure	-	-	1 t/ha (5%)
16-20-0(ammonium phosphate)	40-240 kg/ha (56%);20-100 kg/ha*	9-100 kg/ha (15%)	40-240 kg/ha (43%)
18-46-0(diammonium phosphate)	40-240 kg/ha (18%);6-10 kg/ha*	3-120 kg/ha (35%)	40-240 kg/ha (33%)
46-0-0 (urea)	40-150 kg/ha (72%);5-100 kg/ha*	10-100 kg/ha (33%);4-5 kg/ha*	40-100 kg/ha (48%)
14-14-14	20-40 kg/ha (8%)	10-20 kg/ha (13%)	15 kg/ha (5%)
21-0-0 (ammonium sulfate)	-	10-100 kg/ha (13%)	-

* amount applied during rearing phase; n = number of farms surveyed

4.2. Organic and inorganic fertilizers

Fertilization is a standard practice in pond preparation to promote growth of natural food and consequently, fish production. The amount of fertilizer required varies with intensity of culture, with extensive system requiring heavy inputs of fertilizer as they rely completely on the natural productivity of the ponds. Semi-intensive and intensive culture systems require less fertilizer but with greater inputs of formulated feeds. In shrimp culture, fertilizers are applied to stabilize plankton blooms.

Most farms use both organic and inorganic fertilizers to produce and sustain natural productivity (Table 3). Animal manure from chicken is the most commonly used organic fertilizer. Inorganic fertilizers supply the nitrogen-phosphorus-potassium (N-P-K) requirement of pond bottom soil derived from urea and ammonium phosphate (16-20-0 or 18-46-0).

4.3. Disinfectants

Chemicals are routinely used as prophylactic or disinfectant to prevent disease, or as therapeutant to control disease. Because of the havoc brought about by luminous *Vibrio*, disinfection of the incoming water has become a standard practice in some shrimp farms. Water is pumped into reservoir ponds and treated either with chlorine in the form of calcium hypochlorite or formalin (Table 4).

Table 4. Disinfectants used in black tiger shrimp brackish water farms in the Philippines. Amount in parentheses are percentage of users.

Chemical	Shrimp (n=40)	Polyculture (n=21)
Calcium hypochlorite*	5-100 ppm (33%)	25-50 ppm (10%)
Formalin*	5-20 ppm (10%)	-

* applied in water reservoir; n = number of farms surveyed

4.4. Pesticides

Pests and predators that reduce production are eliminated or controlled using organic or inorganic pesticides prior to stocking. These are necessary when ponds or some areas of the ponds can not be drained completely. The most commonly used organic pesticide is teaseed (Table 5), a by-product from oil processing of the seeds of the tea plant, *Camellia* sp. The seeds of the plant contain 10-15% saponin which is effective in eliminating unwanted predatory fishes. Tobacco dust, a by-product of cigarette production, is another organic pesticide used in milkfish ponds.

Some farmers use inorganic pesticides such as Brestan 60® (triphenyl tin), sodium cyanide and Thiodan® (endosulfan) in milkfish ponds. Brestan 60® is used mainly to eliminate brackish water pond snail, *Cerithidea cingulata*. In shrimp farms, pyrethroid

Table 5. Pesticides used during pond preparation in milkfish and black tiger shrimp brackish water farms in the Philippines.Amount in parentheses are percentage of users.

Trade name (a.i.)	Milkfish (n=39)	Shrimp (n=40)	Polyculture (n=21)
Teaseed (saponin)	10-50 kg/ha (59%)	15-30 kg/ha (80%)	20-25 kg/ha (67%)
Brestan 60® (triphenyltin acetate)	0.25-1.5 kg/ha (36%)	-	0.25-0.75 kg/ha (14%)
Sodium cyanide	0.5-6 kg/ha (21%)	-	1-6 kg/ha (38%)
Tobacco dust (nicotine)	500-1,500 kg/ha (13%)	-	-
Thiodan (endosulfan)	0.1 ppm (8%)	-	0.1 ppm (10%)
D-crab (pyrethroid)	-	1 ℓ /ha (10%)	-
Clear-97 (trichlorfon)	-	20 kg/ha (8%)	-

a.i., active ingredient; n = number of farms surveyed

(D-crab®) and trichlorfon (Clear-97®) are occasionally used to eliminate unwanted organisms.

4.5. Feed additives

Various vitamins and/or multivitamins are added to feeds to promote growth and survival of cultured shrimp (Table 6). Feed additives are also used when stunted growth, deformities and diseases are observed in shrimp. Vitamin C is the most commonly used feed additive in shrimp farming.

4.6. Probiotics

Probiotics or bioaugmentation products are bacteria and enzyme preparations that enhance decomposition of organic material. Probiotics are reported to reduce the amount of pond sludge. Various commercial probiotics are available, usually imported from Europe, Thailand and U.S.A., and are used in intensive shrimp farms (Table 7). These are applied either during pond preparation and/or rearing phase, in rearing water or incorporated in the feeds. Application rates are based on manufacturer's recommendation.

5. Disease Problems

Most shrimp farms (34%) experienced white spot shrimp virus (WSSV) and luminous bacteria for the past 5-6 years. Other disease problems encountered are tail rot (25%), black/brown gill disease (16%), chronic soft-shell (15%), ciliate infestation on shrimp's body/gills (7%), red disease (5%) and barnacle infestation on shrimp's body (3%).

Table 6. Feed additives used in black tiger shrimp brackish water farms in the Philippines. Amount in parentheses are percentage of users.

Feed additives	Amount used
Vitamin C	2-20 mℓ/kg feed (28%) 1-5 g/kg feed (15%)
Multivitamins	
Hypo fat	5 g/kg feed (8%)
Shrimp Activa	1 g/kg feed (5%)
Solvi trace	2-10 ml/kg feed (3%)

Table 7. Probiotics used in black tiger shrimp brackish water farms in the Philippines.

Probiotic	Amount used
BZT Waste digester	1-2 kg/ha, pond prep. 150-800 g/ha, DOC 1-150
BZT Aquaculture	300-500 g/ha, 5-7d before stocking 50-200 g/ha, DOC 1-150
Super PS	30-50 ℓ /ha, pond prep. 5-8 ℓ /ha, rearing phase, every 5-10 d
Super Biotic	6 kg/ha, rearing phase, DOC 1-90, weekly 5-10 g/kg feed, DOC 3-30, 2-3 x/day 10 g/kg feed, DOC 31-60, 2-4 x/day
Super NB	1 ℓ /ha, weekly, DOC 60 up to harvest
Zymetin	5-10 g/kg feed, rearing phase, DOC 3-30, 2-3 x/day 10 g/kg feed, DOC 31-60
Ecomarine	25 tablet/ha, pond prep.
NS-SPO Series	2-3 kg/ha/culture, 7 day interval
BYM	5-15 kg/ha, rearing phase
Biobase	10 kg/ha, pond prep. 17 kg/ha/wk, rearing phase

DOC, days of culture

6. Disease Intervention Methods

Disease intervention methods or health management practices employed among the shrimp farms surveyed includes: (1) screening for viruses and *Vibrio harveyi* prior to stocking of postlarvae and juveniles in nursery and grow-out farms (100%); (2) lowering of stocking density (70%); (3) use of water reservoir with fish or green water culture system, mostly using tilapia (65%); (4) use of commercial probiotics (68%); and (5) employment of biosecurity measures (35%).

The biosecurity measures include the use of tire bath for incoming vehicles (Fig. 2a), foot bath for footwear, and hand washing and disinfection at the farm entrance for farm personnel and visitors (Fig. 2b). The tire and foot baths contain a strong solution of chlorine or formalin while hand disinfectant commonly used is 70% ethyl alcohol. Bird scaring device (Fig. 2c) and crab fence using polyethylene liners along the side of the dikes (Fig. 2d) are installed to prevent entry of animals that are possible carriers of viruses. Entry of non-farm personnel is also limited. Individual ponds have designated tools and materials for exclusive use. Farm personnel are also advised to have specific work clothes.

Discussion

The use of chemicals in the aquaculture industry is widely recognized. Various chemical and biological products are applied to soil and water during pond preparation and culture period, or incorporated in artificial feeds. Among the many uses of chemicals in aquaculture the most notable are to: enhance natural aquatic productivity; maintain optimum physicochemical parameters required for growth of the cultured animal; and prophylaxis and treatment of disease problems.[6, 7)]

Fig. 2a. Tire bath for vehicles at the entrance of shrimp brackish water farm.

Fig. 2b. Foot bath and hand disinfection at the entrance of shrimp brackish water farm.

Fig. 2c. Bird scaring device: polyethylene ropes 2-3 m above the water surface (arrow), with 30 cm distance in between ropes are installed to prevent birds from dropping their fecal matter to the ponds.

Fig. 2d. Crab fence: polyethylene sheets and nylon screen nets are lined along sides of pond dikes as fence to prevent entry of disease-carrying organisms such as crabs and other crustaceans.

However, the widespread and indiscriminate use of chemicals, particularly antibiotics, has resulted in many problems including mortalities and morphological deformities of non-target organisms, development of antibiotic-resistant pathogenic bacteria, and an increasing threat to the environment and public health.[2, 8-15)]

The present farm survey showed that the most common chemicals in use are lime and fertilizers. Application of these products is a standard practice during pond preparation and used mainly for soil and water treatment and for generating fertility in ponds, and thus pose minimal environmental and public health risks. Chicken manure is the most commonly used organic fertilizer as it is reported to contain higher amount of soluble salts, and organic and inorganic substances, ensuring fast zooplankton production.[16)]

The pesticide teaseed is the second type of chemical most commonly used. Saponin, the active ingredient of teaseed, not only eliminates unwanted organisms in the pond but also induces molting of the cultured shrimp.[1)] Pesticides such as Brestan 60®, sodium cyanide and Thiodan® are still in use but only when necessary such as in areas where total draining and drying of pond bottom is impossible. These products are banned in the Philippines (http://www.fadinap.org/philippines) because they are highly toxic, non-biodegradable, accumulate in the pond soil, and with high potential to accumulate in animal tissue.[17)] The efficacy of alternative biodegradable pesticide such as tobacco dust, a waste product of tobacco and cigarette industry, against *C. cingulata* under laboratory conditions has been reported.[18)]

Chlorine is widely used to disinfect rearing water in fish and shrimp hatcheries.[19)] Recently, chlorination of incoming water supply has become a standard procedure

in shrimp ponds. The rate of application in the present farm survey is, however, highly variable. This could be attributed to the amount of organic material present in the water.

Probiotics are currently considered as an alternative to antibiotic treatment. Probiotics are beneficial bacteria which overwhelm pathogens by producing inhibitory substances or by preventing pathogenic colonization in the host.[20] Most formulations originate from temperate countries and are originally developed for waste water treatment. Of the various commercial probiotics available in the market, a notable feature of the results is the mixed success in controlling disease problems. This suggests that more emphasis is needed on development of effective health management strategies at the farm level.

Feed additives such as vitamins C and E, essential fatty acids and carotenoids have been reported to enhance disease resistance and improve overall quality of the aquatic product.[21-24]

In milkfish culture, apart from lime and fertilizers, which are unlikely to give rise to any significant negative environmental impact, the overall use of chemicals is low. With regards to shrimp farming, results of the survey show that antibiotics are no longer part of disease control program and have been replaced by more environment-friendly measures.

Unlike in shrimp culture, disease is not a serious concern in milkfish culture in brackish water ponds. This could be attributed to the relatively low level of industry development in milkfish compared with shrimps. White spot shrimp virus (WSSV) is still the major disease problem in shrimp culture. Other diseases like tail rot, black/brown gill and soft-shelling occur at minimal rate and thus not of significant concern to shrimp growers.

The occurrence of health problems and disease outbreaks is recognized as the biggest constraint to production, development and sustainability of aquaculture. Some infectious diseases can be avoided by pond management such as lowering of stocking density, maintenance of good water quality and good husbandry practices. Farm and health management practices focusing on disease prevention rather than treatment, maintenance of hygiene and biosecurity measures, and the responsible and effective use of chemicals could be the key to sustainability of aquaculture.

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