Disease Management of Shrimp through the Aquamimicry System

Aquaculture is a rapid growing sector in Bangladesh, one of the world's leading fish producing countries with a total yearly production of around 45 lakh MT. Shrimp farming has emerged as a very profitable fisheries enterprise in Bangladesh with a yearly output of about 2.4 lakh MT. In recent years, however, shrimp farmers have been facing the early mortality syndrome (EMS) or acute hepatopancreatic necrosis disease (AHPND), white spot syndrome virus disease (WSSV) occurring due to intensification and other reasons related to climate adversities, management shortcomings, etc. There has been a gradual decline in production as well as shrimp exports over the last few years threatening the shrimp industry. To manage fish diseases farmers often use different aqua drugs, chemicals, feed additives and antibiotics which are unsafe for humans as well as for the environment. New culture techniques ensuring natural biosecurity and environment friendly and economically profitable management practices are required to address the disease problem and ensure sustainable shrimp production. Organic shrimp farming is a merging alternative modern system of ecofriendly aquaculture production with a reduced artificial feed supply, known as “Aquamimicry’. It is a promising technology for stable production with a self-nitrification process within culture ponds and zero water exchange. In Bangladesh, no scientific study on Aquamimicry was conducted in the past. In this backdrop, for developing an alternative organic system of shrimp disease management, scientists of the Fisheries Biology and Aquatic Environment, BSMRAU implemented a project in Shyamnagar upazila of the Satkhira district, reputed for shrimp culture, in southwestern Bangladesh region with a view to controlling unexpected diseases, and ensuring shrimp production in an environment friendly and economically profitable manner. The major objective was to adapt the Aquamimicry system to existing cultural practices for brackish water shrimp production in Bangladesh.

Methodology

A shrimp farm (Meghla Shrimp Farm), located at Abadchandipur, Munshiganj, Shymnagar upazila, Satkhira was selected for conducting this research. Six experimental ponds each 2000 m2 in size were prepared for the Aquamimicry system.

Fig. 1. Operation of paddle wheel water aerators in the Aquamimicry system pond

KRISHI GOBESHONA FOUNDATION
A non-profit foundation for sustainable support to agricultural research and development

The ponds were prepared with dyke repairs, bottom cleaning and sun drying to kill unwanted benthic organisms that could hamper shrimp production. The pond embankment was compacted and covered with grass to minimize dyke erosion which benefited the culture system by lowering the pond sludge volume. Lining of dykes with HDPE sheet was done to avoid seepage through the embankment. To maintain biosecurity, individual experimental ponds were fenced with blue nets. Necessary electrification system was in place for pumping water and operating paddle wheels (Fig. 1) for pond water aeration. The shrimp farm was connected to the Chuna Nadi river through the Khoshalkhali canal enabling the ponds to be filled up with saline river water during high tide. An underground water pump was installed for supplying freshwater to each pond as and when necessary. Water to fill the ponds was made to pass through a 100 micron mesh water filter. The average depth of water in the nursery and grow-out ponds was maintained at 3.0 and 4.0 ft, respectively. After filling the ponds, water was allowed to settle for 24 hr. After settling, the pond water was treated with bleaching powder @ 60 ppm for cleaning. Chain dragging was done for mixing of the pond water and removing unwanted gases from the bottom of the pond. In addition, the aerator was operated starting with the 3rd day to eliminate chlorine from the water. This procedure was followed for up to 5 days.

Table 1. Experimental design for the Aquamimicry system

Treatment	Culture system	Feed application
T_0	Existing semi-intensive	100% CF
T_1	Aquamimicry	10% LFRB/LFSM + 90% CF
T_2	Aquamimicry	30% LFRB/LFSM + 70% CF

CF= commercial feed, LFRB)= liquid fermented rice bran, LFSM= liquid fermented soybean meal

The feeds used were commercial feed (CF) alone and combinations of CF, liquid fermented rice bran (LFRB) and liquid fermented soyben meal (LFSM). The experimental design is shown in Table 1.

For the preparation and application of LFRB and LFSM as supplemental feeds for Aquamimicry culture, 10 liter of water was mixed with 1 kg of ground rice bran or soybean meal and kept for 24 hours with continuous aeration. A commercial probiotic (Red Cap) was used for fermentation. The pH of LFRB or LFSM was maintained at 6.0-7.0. Calcium carbonate was used to buffer the pH. Before stocking of shrimp seeds (PL), the ponds were filled with available saline water through filtration. LFRB, LFSM, molasses and probiotics were applied to the experimental ponds to allow growing natural fish feed. Stocking of specific pathogen-free (SPF) post-larvae (PL) was done at stock densities of 9-10 PL/m2. Commercial feed was used as the feed supplement on top of LFRB and LFSM. Water quality parameters (temperature, salinity, ammonia, alkalinity, transparency and pH) and plankton growth were monitored at regular intervals and analyzed on the spot and in the BSMRAU laboratory. Quantities of plankton in the Aquamimicry and existing culture system ponds were as analyzed fortnightly. Microbial analysis of samples collected from water, soil and shrimp of Aquamimicry and existing culture ponds was done separately to isolate and characterize the microbes fortnightly. Weight gain of the shrimp was recorded once a week, specific growth rate (SGR) and average growth rate (AGR) were calculated. To study immunological parameters of shrimp, total haemocyte count (THC) and histological analysis were done on haemolymph and hepatopancreas samples, respectively.

Results and Outputs

The water quality parameters were found to be suitable for shrimp culture irrespective of treatment. Water transparency in the treatment ponds was lower than that in the control pond.

It could be due to the application of fermented rice bran in the Aquamimicry system, which might enhance phytoplankton growth. Transparency is a good indicator of the amount of nutrients and the overall health of a pond. However, pH was high (8.11±0.14) in the control pond compared to the Aquamimicry ponds. The high level of pH and transparency could create unfavorable condition for shrimp resulting in rapid diseases infestation in the control pond with the existing culture practice.

Plankton concentrations in the ponds were affected by the treatments. LFRB/LFSM increased phytoplankton and zooplankton production by 38-40% over that in control ponds. The quantity of plankton was higher in the Aquamimicry ponds than that in the existing culture ponds. During rainfall, the quantity of plankton decreased, but the quantity in Aquamimicry pond still remained relatively high.

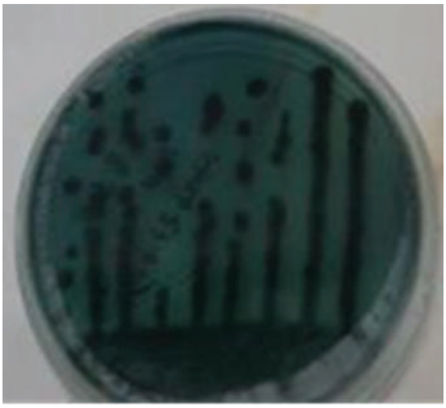

Fig. 2. Colony of V. *parahaemolyicus* found in control ponds

Growth of beneficial microbes not only supplements the feed but also balances the natural ecosystem and eliminates pathogenic microorganisms. Several *Vibrio* and *Proteus* species were identified. Most importantly, the control pond samples (soil, water and hepatopancreas of shrimp) had *Vibrio parahaemolyticus* (Fig. 2), the key pathogenic microorganism responsible for EMS (early mortality syndrome) disease in shrimp, but it was not found in the Aquamimicry ponds.

Fig. 3. Growth of shrimp in control pond (left) and Aquamimicry pond (right after 45 days of rearing)

The overall survivability in the control pond was the lowest. Only 30% shrimp survived in the control pond while in one pond of treatment T_2 (Aquamimicry) it was 60%. The higher mortality occurring in the existing ponds might be due to the presence of pathogenic strains *V. parahaemolyticus,* which was confirmed by microbial analysis. The average weight gain of shrimp, SGR and AGR of shrimp of Aquamimicry ponds were higher than those in the control ponds (Fig. 3). The stock of the control ponds crashed within 45 days but the stock of treatment ponds specially 30% LFRB treatment gave the best result in case of survival rate and growth performance.

A hemocyte is a cell that plays a role in the immune system of invertebrates. Hemocytes are phagocytes of invertebrates. The shrimp's mechanisms of defense against external agents such as viruses and bacteria include the production of hemocytes, the defense cells present in the blood of shrimp. Due to this reason, the survivability of shrimp in T_1 and T_2 was higher than that in the control (T_0) ponds. The higher amount of THC count indicates better immune performance of the shrimp in the treated ponds.

As regards the immune system, the histological analysis of the hepatopancreas of shrimp showed normal and well developed shapes of hepatopancreatic tubule in T_1 and T_2 (where the shrimp of T_2 had the most regular shape), whereas shrimp from T_0 showed irregular and undeveloped hepatopancreatic tubule. This result also indicated better health of the shrimp in the Aquamimicry ponds than in the control pond. The results of the proximate analysis showed that Crude protein and carbohydrate contents were found to be higher in the shrimp of Aquamimicry ponds than those of shrimp from the shrimp control pond (T_0). The crude lipid content was highest in T_2. These results indicated a better biochemical composition of shrimp in the Aquamimicry pond.

A cost-benefit analysis was done after the experiment; T_2 (70% CF+30% LFRB) brought about higher profits. Some profit was derived from cultured shrimp with the Aquamimicry treatment whereas there was no profit from the traditional ponds. The Aquamimicry system appeared to be an attractive and sustainable option for shrimp culture in Bangladesh.

Expected Impact

Shrimp producers are looking for ways to increase the productivity and sustainability of shrimp culture throughout the world. Aquamimicry can be a good option. This technology of shrimp farming that relies on generation of live feed (living organisms) produced by providing beneficial bacterial fermented carbohydrates to the culture system, which mimics the natural situation in aquatic ecosystems. In this system, the non-use of aqua-drugs and aqua-chemicals would ensure an ecofriendly aquaculture environment producing healthy, disease-free non-toxic fish for humans.

Recommendations

- A separate nursing system may be helpful to sustain this technology as the most vulnerable stage for shrimp is first two months
- Controlled nursing system where temperature and salinity will be stable is required for smooth shrimp farming
- Stocking densities need to be fine-tuned
- Further research is needed to find the cause(s) of sudden mortality

---

This Technical Bulletin has been prepared on the basis of technical information available from a completed BKGET-KGF Funded CGP Project, the details of which are given below:

Project Code and Title: TF 39-F/17. Adaptation of Disease Management Strategy in the Existing Culture Practices of Shrimp through Aquamimicry System

Principal Investigator: Dr. SM Rafiquzzaman, Professor, Dept of Fisheries Biology and Aquatic Environment, Gazipur Agricultural University, Gazipur, Cell: 01754041311, e-mail: bokul44@yahoo.com

Project duration: December 2017 to March 2024

Edited by:
Nasrin Akter, GM Panaullah and Nathu Ram Sarker
Krishi Gobeshona Foundation (KGF)

Published by:
Krishi Gobeshona Foundation, AIC Building, 3rd Floor, BARC Campus, Farmgate, Dhaka-1215, Bangladesh, Cell: 01729 480988, Website: www.kgf.org.bd, e-mail: kgf-bd@kgf.org.bd