Use of new technology and skill enhancement to obtain eco-friendly production of Tiger shrimp (*Penaeus monodon*)

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About the HOBAS technology

The HOBAS aeration technology consists of a motor, an impeller (pump), an air hose with a regulating valve, a manometer and a floating raft. The impeller, which is mounted inside the pump at the lower end of the motor, turns rapidly creating a partial vacuum inside the pump. The partial vacuum causes air above the waterline to be pulled into the air intake port where air is dispersed into the water. The air intake port (submerged in the water at the lower part of the pump) is connected to air above the waterline through a hose going onshore. Onshore a valve and a manometer are used to regulate the amount of air being introduced into the impeller. Due to the partial vacuum, the water leaving the pump is slightly over-saturated with oxygen.

Most aerators employed in aquaculture today mix water with air either after the pump (e.g. ejector based aeration) or with a propeller in open water (e.g. Aire-O_2, paddle-wheels). The HOBAS aerator is designed to introduce air directly in the pump housing and mechanically crush the air with water under vacuum without reducing the effect. Suction of false air usually makes pumps less efficient. Moreover, compared to other aeration technology, the HOBAS technology also introduces several other advantages in practical farm management:

- Farmers can freely regulate the depth and position of the inlet and outlet of the pump
- Farmers can freely regulate the angle of the outlet from the pump and thus avoid agitation of the pond bottom independent of pond water depth in addition to controling the direction of the physical water current according to the pond shape (individually adjustable)
- Farmers can control and regulate the amount of aeration according to the DO level in culture water (e.g. no aeration during the day – full aeration during the night, or somewhere in-between these categories)
- The pump prevents any kind of stratification and creates uniform conditions in the water column
- The HOBAS technology is easy to use, has low maintenance, runs more smoothly and makes less noise than competitive technology

Introduction

The Norwegian R&D company HOBAS Tropical Aquaculture LTD, has been working in Sri Lanka since 1999. At that time, the shrimp farming industry was severely struck by disease outbreaks and bankruptcies. Although Sri Lanka does not have a tradition of aquaculture practices, the island experienced an enormous expansion within the shrimp farming sector in the beginning of the 1990s. This rapid development was mainly possible due to a high economic return on investments and free access to unpolluted water from local lagoons. During this period (1990 – 1995), neither the environment nor the welfare of the shrimps was considered, and as a result, the industry collapsed in 1997/1998. As recently as December 2003, the industry along the western coast of Sri Lanka was again struck by a severe disease outbreak. Thus, it is now evident that measures need to be initiated in order to improve farm management and reduce the negative environmental impact from shrimp farming. The industry today realises the importance of unpolluted brackish water and suitable land sites for pond construction, and the present focus is on sustainable production yields, preserving coastal environments and achieving an eco-friendly production.

Material and methods

The present study was conducted in cooperation with Rogaland Research in Stavanger, Norway. The overall aim of the project was to evaluate the possible effects on water quality in earthen shrimp ponds when production was intensified by means of new technology. Four small-scale commercial ponds stocked with three different densities (12, 25 and 31 PLs m^{-2}) and applied three different aeration technologies were used. These were the HOBAS technology, ordinary paddle-wheels and Aire-O_2 diffuser system. The ponds were approximately 40 x 40 meters with a water depth of 3 feet (pond volume: 1920 m^3). Continuous monitoring of dissolved oxygen (DO), pH, temperature, salinity, carbon dioxide (CO_2) and ammonia (NH_3) were performed during the entire production cycle. DO, pH, salinity and temperature were measured by a hand-held YSI-556 MPS (Multi-Probe-System) instrument. Analysis of CO_2 and TAN were done at Rogaland Research's certified QA-lab in Stavanger.

In addition, water current velocities were measured along a transect (10 meters from shore) in all four ponds to compare the different aerator's ability to maintain the horizontal water circulation. The water current velocities were monitored by an Aquadop Current Meter measuring velocity (cm/s, accuracy: 0.5 cm/s or 1%) and direction (accuracy: 0.1?).

Results

The results are indicating, first and foremost, that the HOBAS technology is able to keep key water quality parameters (O_2, CO_2, TAN, (salinity), pH and temperature) un-stratified, stable and within acceptable levels in semi-intensive and intensive shrimp culture. Most efficiently, the HOBAS aerator totally removed the potentially toxic gases (CO_2, NH_3) in a highly intensive pond (stocked with 31 PLs m^{-2}). Neither paddlewheels nor aeration using diffusers proved a similar effect (Figure 1).

Moreover, the three ponds installed with standard aeration equipment (e.g. paddlewheels) did allow the accumulation of CO_2 and TAN during the last month of the production cycle. The HOBAS technology employed in this trial was superior to the others flushing capacity wise. These results clearly demonstrate that the existing technology commonly employed in shrimp farming today is not adequate to keep CO_2 and TAN at acceptable levels; at least not during the last period of the production cycle of intensive culture.

The HOBAS aerator also displayed a better utilisation of nutrients. Contrary to the other three ponds, a very healthy phytoplankton growth was observed where no algae mats (lap-laps) were produced. This simply implies that nutrients (nitrates and phosphates) were suspended in the water column for a longer time, and a larger concentration was therefore used to stimulate the bloom before sedimentation or being discharged. Moreover, the HOBAS technology maintained an optimum horizontal water current velocity (3.4 - 7.3 cm s^{-1}) in the pond which corresponds to the acceptable range suggested by Peterson et al. (2001). According to the numbers employed, paddlewheels either created too high velocities (14.9 – 20.9 cm s^{-1}) or insufficient velocities (1.5 – 5.1 cm s^{-1}).

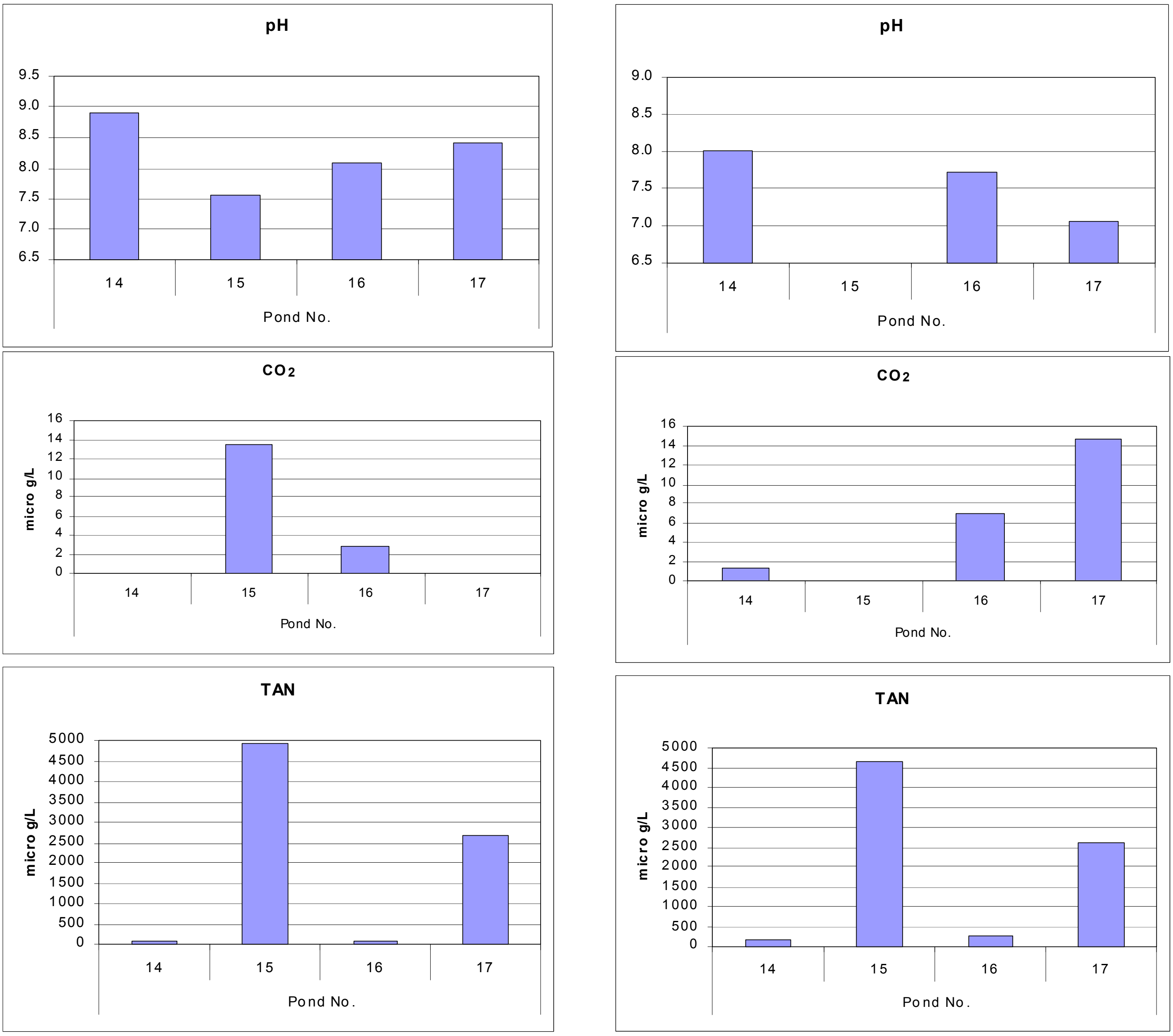
Discussion

During the last decades, there has been a development towards more efficient and intensive production units in several shrimp producing countries. In light of the worldwide debate on environmental and socio-economic issues, the industry clearly needs to produce shrimp more efficiently. However, important prerequisites for the long-term sustainability of shrimp farming have often been neglected in the past. In order to achieve an eco-friendly production, farmers must understand the complex mechanisms controlling the water quality and use technology suited for intensive production.

Poor water quality conditions in ponds stress the shrimps, which subsequently makes them more susceptible to disease. The biggest stressors are mainly toxic levels of carbon dioxide (CO_2) or ammonia (NH_3) which are much more likely to occur in intensive systems. Traditionally, CO_2 and TAN levels are seldom measured in commercial shrimp farming. According to EIFAC (1986), the daily cycle of metabolite levels in culture water should be determined at least once during the production cycle in order to locate the periods of maximum and minimum levels of the relevant water management components (DO, pH, TAN, CO_2). Therefore, in intensively run farms (20 PLs/ m^{-2} and upwards), it is of vital importance to know the exact concentration of these potentially stressful and toxic components. The results from the present study confirm the importance of monitoring water quality throughout the production cycle in intensive systems.

Furthermore, the organic content in effluent causing unwanted eutrophication in lagoons tends to be much higher in semi-intensive and

Figure 1. Sampling of pH, carbon dioxide (CO_2) and total ammonia (TAN) in four ponds in July (left) and August 2002 (right) (no pH and CO_2 measured in Pond 15 in August) Pond 14: HOBAS aerator/31 PL m^2; Pond 15: Paddlewheels/31 PL m^2; Pond 16: Paddlewheels/12 PL m^2 (control); Pond 17: Paddlewheels & diffuser/25 PL m^2



intensive farming areas than in extensive systems. In fact, extensive shrimp culture is not expected to represent any significant load of nutrients to the surrounding waters at all (Phillips et al. 1993). Recent studies of shrimp culture in Bangladesh, where mainly extensive systems are employed, support this view (Bergheim & Braaten 2002). Bangladeshi ghers actually function as biofilters and sedimentation ponds (silting) discharging rather unpolluted effluents. However, in more intensive systems, where artificial feeds are the main nutritional source, water being discharged strongly contributes to pollution of adjacent environments. Thus, more efficient technology able to reduce or remove these waste components and to improve the utilisation of available nutrients in the water column is clearly needed to reduce effluent loading in the future.

Conclusions

The overall most important conclusions from the project are:

- The HOBAS technology, contrary to commonly employed technology, will sustain an eco-friendly production of shrimp
- The new technology has a strong ability and a high capacity to flush the possible toxic gasses carbon dioxide (CO_2) and ammonia (NH_3) from culture water in earthen pond systems
- The new technology renders farmers to intensify their production with higher stocking density at reduced risk of sub-optimal water quality conditions and disease outbreaks, and without sacrificing the welfare of the shrimp
- The new technology will work excellently in combination with ordinary paddlewheels and other diffuser aeration systems

Based on the technical results from the testing of the new technology in Sri Lanka, HOBAS has, in cooperation with Rogaland Research (RF) and the Norwegian Institute of Water Research (NIVA), started the process of initiating

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6 day old barramundi larvae (photo: Sagiv Kolkovski)

Conclusion

Gemma Micro has really proved itself as an effective *Artemia* replacement diet for barramundi and a number of other marine species. This will prove a valuable tool for the marine hatchery wishing to reduce costs, improve quality and to put juvenile production onto a more convenient and cost-effective footing. Gemma Micro will give marine fry a 'flying start' and provide a valuable foundation for the next feed in Skretting's product range: Gemma.

For more details please contact the author Trine Karlsrud at Skretting in Australia trine.karlsrud@nutreco.com.

Editors note: We do not endorse any commercial product, the article is merely the view of the author.

Reference

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a skill enhancement programme for shrimp farmers in Sri Lanka (Drengstig *et al*. 2004). This project focuses on communicating Codes of Practices and Best Management Practices, and to facilitate a practical implementation of such voluntary standards among farmers in Sri Lanka. It is beyond all doubts that more efficient technology in combination with an improved understanding of these complex systems will contribute to a more viable shrimp farming industry.

Moreover, NIVA, RF and HOBAS is also cooperating in a major R&D project in India together with the National Institute of Oceanography (NIO), Goa were the HOBAS technology is being tested under commercial conditions. Finally, the HOBAS technology is being tested in Spain under commercial terms for production of the carp tench (Tinka tinka) in earthen ponds. The technology seems highly suitable for pond farming either in brackish or freshwater systems producing fish or shrimp.

Note: Cited references are available from the corresponding author.

Report of the Komodo fish culture project

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A pilot project to establish a multi-species reef fish hatchery in Loh Mbongi and village-based grow-out farms in communities surrounding Komodo National Park, West Flores, Indonesia. Report from The Nature Conservancy, Southeast Asia Center for Marine Protected Areas in collaboration with the Komodo National Park authority.

The main objective of the fish culture project is to provide sustainable fish culture as an alternative livelihood to non-sustainable fishing practices in and around Komodo National Park. A secondary objective relates to the Hong Kong based trade in live reef fish. Currently, the live reef fish trade is rapidly depleting the Indo-Pacific stocks of Napoleon wrasse (*Cheilinus undulatus*) and groupers (Serranidae). It is hoped that the Komodo fish culture project can demonstrate how fish culture of groupers can be done in a sustainable and environmentally sound manner, thereby contributing to the market transformation of the live reef fish trade from unsustainable, capture-based to sustainable, culture-based.

The Komodo fish culture project aims to involve local communities in the grow-out of estuary grouper *Epinephelus coioides*, mouse grouper *Cromileptes altivelis*, tiger grouper *Epinephelus fuscoguttatus*, sea bass *Lates calcarifer* and mangrove jack *Lutjanus argentimaculatus*, which can be marketed as live product to the Hong Kong - based live reef fish trade.

Fingerlings are produced from captive broodstock in a hatchery situated in Loh Mbongi (ca. 6 km North of Labuan Bajo). The pilot project aims to produce 25 tons of live fish yearly, to be realized over 3-4 harvests per year per grow-out unit. A grow-out unit consists of a complex of 16 floating cages, varying in size between nine and 25 m^2 surface area. In the pilot phase, four grow-out units will be deployed near the villages that are participating. The produced volume will consist of a mix of the five species for which broodstock is presently secured. This multi-species approach reduces risks related to species-specific vulnerability to disease and to fluctuation in consumer preference and price. The species composition of initial batches of fingerlings will depend on hatchery practicalities, as this batch will be used for training in grow-out in village-based fish farms rather than for the generation of revenue.

In the pilot phase (i.e. production capacity of 25 tons annually) the project will involve ca. 20 villagers on a full-time basis, but many more will be trained in grow-out techniques. Once economic viability and environmental sustainability have been demonstrated, a carrying capacity analysis will be carried out to determine the optimal production capacity, after which a private business partner will be invited to upscale and develop the project into a