Scientific advisory on water quality management for traditional fish farms

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Finfishes as well as shrimps are farmed in tide-fed ponds in several parts of central Kerala. These small scale farmers are at times affected by mass mortality of stocked fish. Most often, such mortalities of farmed stock are not extensive, but restricted to individual farms. Farmers who observe fish mortalities or some change in water quality seek the help of Fishery Environment Management Division of the Central Marine Fisheries Research Institute, Kochi for expert opinion to redress the problem.

A common problem faced by the shrimp farmers in the area is poor pond water quality. This can be due to mixing of waste water from nearby households which are let out into the common feeder canals. The changes in the chemical parameters of a farm which encountered mass mortality of fishes and the advisories given to improve the water quality are detailed below.

The aqua-farm is located at Edavanakkad, Vypeen Island, Kerala and mass mortality of fishes was observed in November 2010. The farm was stocked with fishes like pearl spot (*Etroplus suratensis)*, mullets (*Mugil cephalus* and *Liza parsia*) and shrimps.

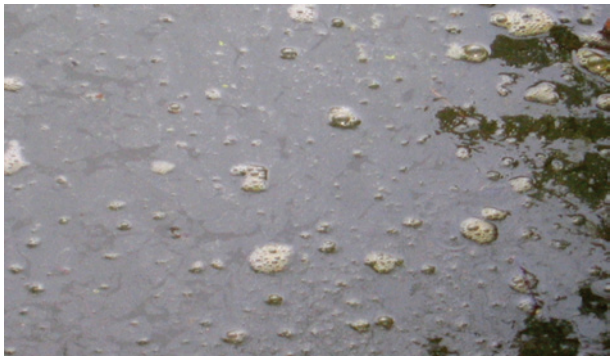

Fig. 1. Affected pond at Edavanakkad, Vypeen Island

Water samples were taken from the water entry point as well as from two different points of the affected pond (Fig. 2) for analysis. For comparison, water samples were taken from a distant canal as reference. Representative bottom sediment samples were also collected from these three stations (Fig. 3).

The water samples were analysed for pH, salinity, dissolved oxygen, total ammonia-nitrogen,

Fig. 2. Water sample collection for dissolved oxygen analysis

Fig. 3. Soil sample collection

nitrite-nitrogen, nutrients (phosphate and silicate), dissolved carbon dioxide, gross and net primary productivity as well as turbidity using standard methods. The sediment pH was also noted.

The pH of the water in the water entry point was acidic in range. This water when mixed with water in affected ponds changed to alkaline range (Fig. 4). A reference pond (non-affected pond) in the nearby area with alkaline range of pH clearly indicated that the mixing with acidic pH water has converted its alkaline pH to acidic range.

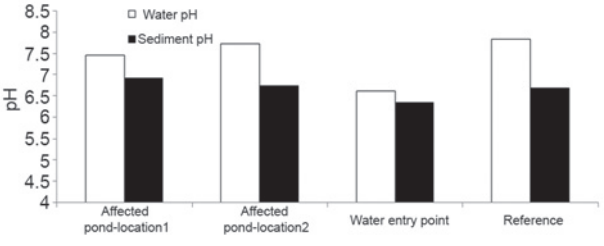

Fig. 4. Water and sediment pH

The dissolved oxygen content of contaminated water at water entry point was low compared to that of reference pond (Fig. 5). The CO_2 concentration of the entering waste water was higher than the maximum permitted limit of 5 mg l^{-1}. After mixing with the affected pond water, because of its high dissolved oxygen concentration, the effect of high CO_2 got nullified (Fig. 5).

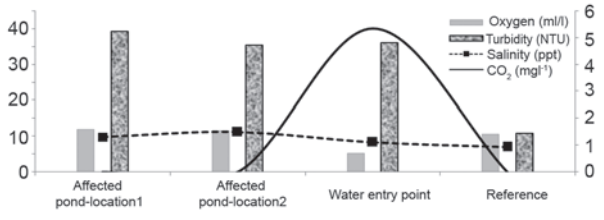

Fig. 5. Selected hydrological parameters recorded

The water entering the affected pond also showed very high NH_3-N levels (0.459 mg l^{-1}) and PO_4-P (0.622 mg l^{-1}). It was observed that after mixing with the affected pond water, because of its high dissolved oxygen concentration, the effect of high NH_3-N got nullified (Fig. 6). Hence the total toxic forms of dissolved inorganic nitrogen (ammoniacal and nitrite nitrogen) did not exceed the permissible levels of 0.1 and 0.5 mg l^{-1} respectively. After mixing with the water in affected ponds, PO_4-P remained as such retaining the PO_4-P in dissolved form in water, because of the high DO in water of the affected ponds and no further oxidation of PO_4-P was possible.

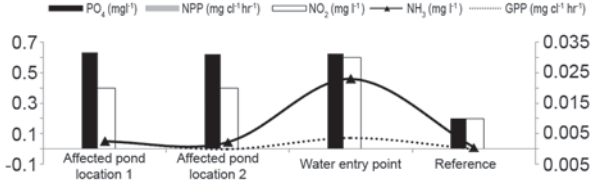

Fig. 6. Dissoloved inorganic phosporous (DIP), dissoloved inorganic nitrogen (DIN) and primary productivity in water

The high dissolved inorganic phosphorus (DIP) and low inorganic nitrogen species has resulted in a highly imbalanced nutrient ratio of N/P. The very high phosphate levels in water might have resulted from the house hold waste water which entered the affected pond. The bubbles on the pond surface indicated presence of detergent in water. Detergents that contain phosphates are highly caustic, and surfactant detergents are very toxic. Surfactant detergents are used to enhance the wetting, foaming, dispersing and emulsifying properties of detergents. Phosphate detergents are used to soften hard water and help suspend dirt in water.

Detergents can have poisonous effects on all types of aquatic life. All detergents destroy the external mucus layers that protect the fish from bacteria and parasites; plus they can cause severe damage to the gills. Most fish will die when detergent concentrations approach 15 parts per million. Detergent concentrations as low as 5 ppm can kill fish eggs. Surfactant detergents are implicated in decreasing the breeding ability of aquatic organisms.

Detergents can also add another problem for aquatic life by lowering the surface tension of the water. Organic chemicals such as pesticides and phenols are much more easily absorbed by fish. A detergent concentration of only 2 ppm can cause fish to absorb double the amount of chemicals they would normally absorb, although that concentration itself is not high enough to affect fish directly. The main contributors to the toxicity of detergents were the sodium silicate solution and the surfactants with the remainder of the components contributing very little to detergent toxicity. However, untreated or primary treated effluents containing detergents can pose a problem.

Advisory for improving water quality

It is essential that house hold effluents are to be properly drained out, without getting them mixed with natural embanked aquatic systems like, ponds, wells *etc*. The PO_4 P accumulation in the present pond can be managed with application of lime as $CaCO_3$, or $CaMgCO_3$ or CaO, in the pond soil. The pond sediment showed acidic soil reaction on observation of sediment pH (Fig. 4). Hence the addition of lime will not lead to excess alkalinity. Addition of lime induces phosphorous fixation as insoluble calcium phosphate, which removes excess phosphate from water and precipitates it in sediment by soil fixation and the nutrient imbalance can thus be overcome.