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Water Quality Assessment of Shrimp Culture Ponds Located in Thondi Coastal Area, Palk Strait, Southeastern India

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Abstract: Aquaculture is a fast-growing and rapidly expanding multibillion dollar industry. The increase in demand and stagnation of catches of shrimp from the wild has given impetus to shrimp farming in recent years. This study has been conducted in the Shrimp farming areas of Karankadu (Pond - 1 and Pond - 2) and Vattanam (Pond - 3 and Pond - 4) in Thondi for a period of six months from February to July 2007. Thondi is an important fishing zone as well as a major Shrimp farming area in Ramnad district, Tamil Nadu, India. During the entire study period, water temperature of 28.9 and 31.5 °C were recorded at pond 2 and 3, respectively. The salinity in the shrimp farm reaches was minimum 32.4 ppt during the month of February at pond 4 and the maximum was 38.8 during the month of July at pond 1. Inorganic reactive phosphate fluctuated with in the range of 0.014 to 0.492 ppm at all the ponds. The entire study period the Ammonia-nitrogen showed well defined fluctuations and the range was observed from 0.011 to 0.956 ppm. Hence, it was concluded that the growth of shrimp has been affected due to elevated concentration of salinity.

Key words: Physico-chemical parameters · Nutrients · Water quality management · Shrimp farm · Ammonia

INTRODUCTION

Aquaculture is concerned with 'the propagation and rearing of aquatic organisms under complete human control involving manipulation of at least one stage of an aquatic organism's life before harvest, in order to increase its production'. Fish catches from the marine environment have been steadily declining in many parts of the world due to overexploitation and pollution; many people are turning to aquaculture to improve the food production and to contribute for economic development. Aquaculture, in India, has made encouraging progress in the past two decades producing significant quantities of food, income and employment. Aquaculture, particularly, tiger shrimp *Penaeus monodon* culture, has extensively been practiced all along the coastal regions of India. Aquaculture is a fast-growing and rapidly expanding multibillion dollar industry. The increase in demand and stagnation of catches of shrimp from the wild has given impetus to shrimp farming in recent years. Shrimp farming is very profitable business compared to agriculture and animal husbandry [1]. Majority of shrimp farms in India is 100 per cent export oriented. Out of a total 1.456 million hectare of brackish water area available in India, 0.902 million hectares are being utilized principally for shrimp farms.

Marine capture fisheries and aquaculture supplied the world with about 104 million tons of fish in 2004 [2]. Of this total, marine aquaculture accounted for about 18%, whereas, shrimp from aquaculture continues to be the most important commodity traded in terms of value (2.4 million tons). Worldwide, the aquaculture sector has been expanding at an average compounded rate of 9.2% per year since 1970, compared with only 1.4% for capture fisheries and 2.8% for terrestrial-farmed meat production systems. It earns foreign exchange and generated employment for large coastal contiguous population [3].

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The success of modern aquaculture is driven by intensive reticulated culture systems [4] whereby high growth rate and high stocking density are major requirements. However, this practice results in the onset of fish disease and environmental pollution [5]. The limiting factor in successful shrimp farming is often identified as water quality management. Water quality management actions undertaken by a farmer are either directed at influencing the biological process of oxygen production (photosynthesis) and consumption (respiration) in the pond, or at the mechanical of oxygen into the water using aerators [6]. Nutrient budget of intensive shrimp farms has been estimated by many authors, but nutrient budget of Palk-starit area not yet studied. However, the serious concern about this industry is disease. Aquatic animals are constantly and intimately related with the composition and changes in the surrounding environment [7, 8]. The Nutrients play a vital role for the survival of shrimp in the aquaculture pond. Poor management of water quality leads to the destruction of culturing animals. Hence the present investigation has been made to study the physico chemical variants in the study area and to investigate the distribution of nutrients in the pond ecosystems.

MATERIAL AND METHODS

The study was carried out in the two stations of Thondi Coast (Fig. 1), Southeast coast of India for a period of six months from February to July 2007. Thondi is an important fishing zone as well as a major Shrimp farming area in Ramnad district, Tamil Nadu, India. The study has been conducted in the Shrimp farming areas of Karankadu (Pond - 1 and Pond - 2) and Vattanam (Pond - 3 and Pond - 4). The various physico- chemical parameters in two shrimp farms were observed during the monthly interval for six months. The water samples were collected with acid-cleaned polyethylene bottles and immediately transported to the laboratory in an ice-box, where they were samples filtered through using Whatman (0.45 µm) GF/C filters, (under vacuum pressure lower than 75 mm Hg) before analyzing the nutrients. The temperature was recorded using standard mercury centigrade thermometer. Salinity was estimated with the help of Refractometer. pH of the water has been recorded in the farm itself using pH meter. Dissolved oxygen was analysed according to Strickland and Parsons [9]. The nutrients levels of shrimp farms such as Inorganic phosphates (PO_4) were determined based on Murphy and Riley [10]. Nitrates (NO_3), Nitrites (NO_2) and Ammonia (NH_3) were measured spectrophotometrically by following the method of Strickland and Parson.

RESULTS

Result of analyses of varies Physico-chemical parameters of shrimp farms are given in Figs- 2 to 10. During the entire study period the recorded maximum and minimum of water temperature were 31.5 and 28.9°C, respectively at pond 2 and 3. The salinity in the shrimp

Fig. 1: Map showing the study area

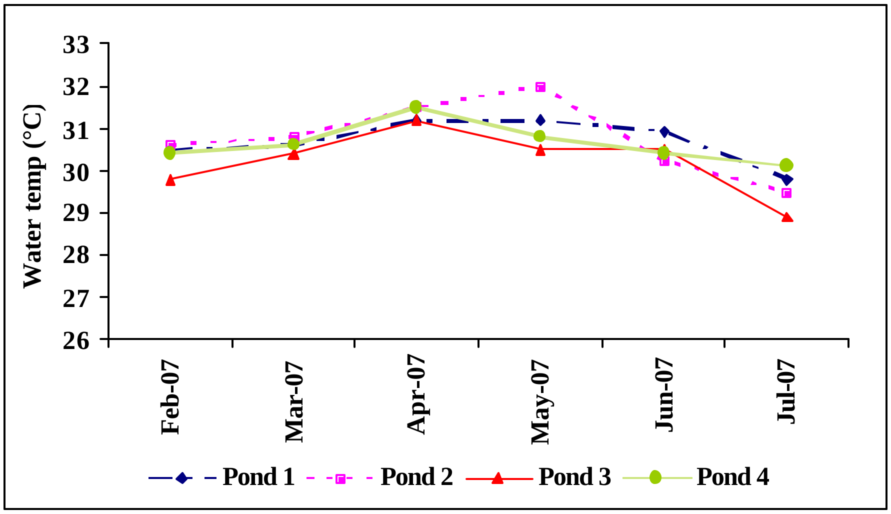

Fig. 2: Monthly variations of water temperature in shrimp culture ponds

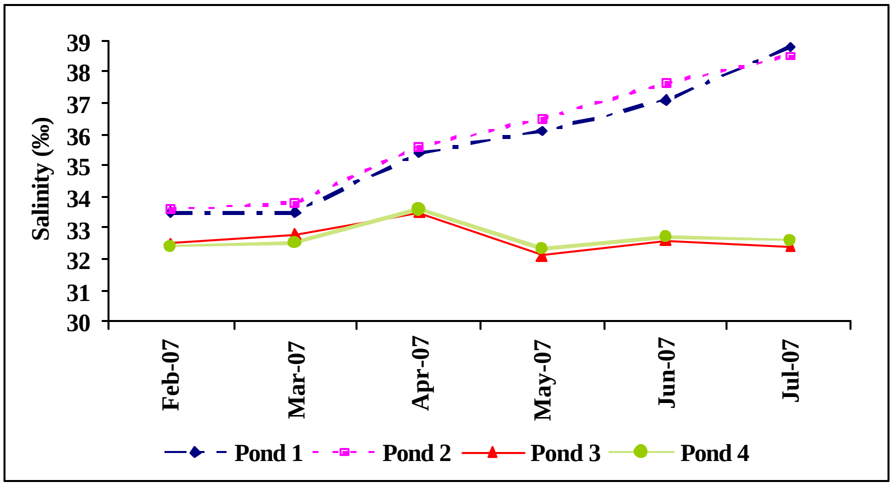

Fig. 3: Monthly variations of salinity in shrimp culture ponds

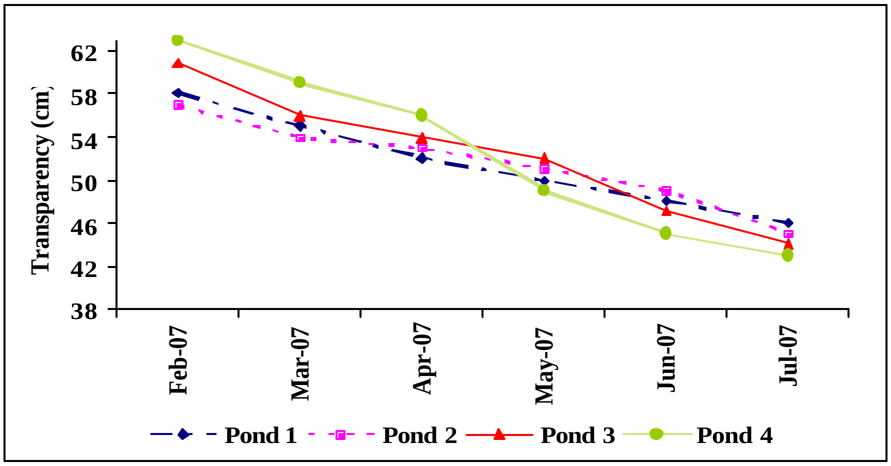

Fig. 4: Monthly variations of transparency in shrimp culture ponds

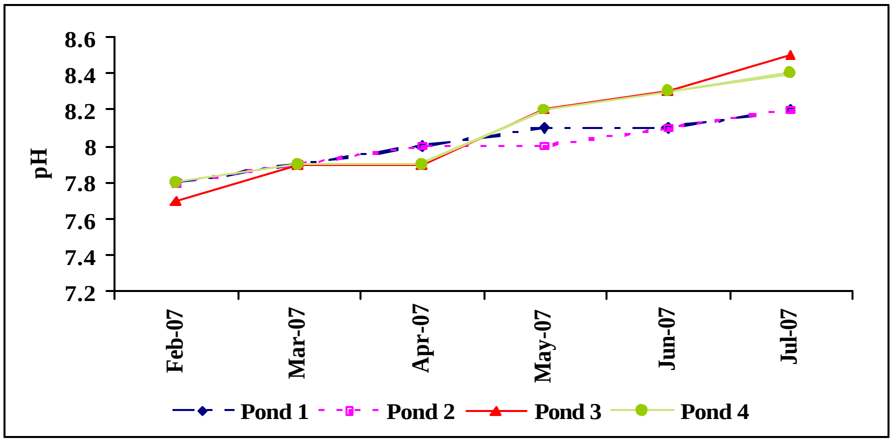

Fig. 5: Monthly variations of pH in shrimp culture ponds

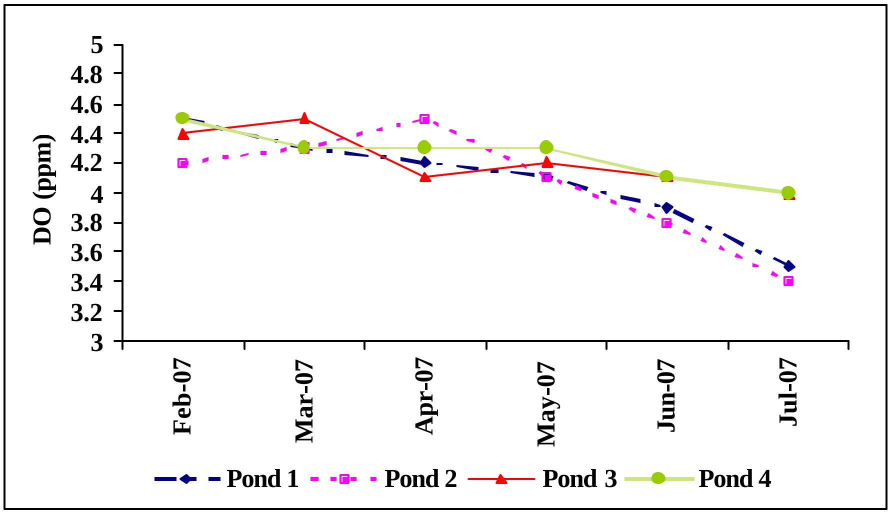

Fig. 6: Monthly variations of dissolved oxygen in shrimp culture ponds

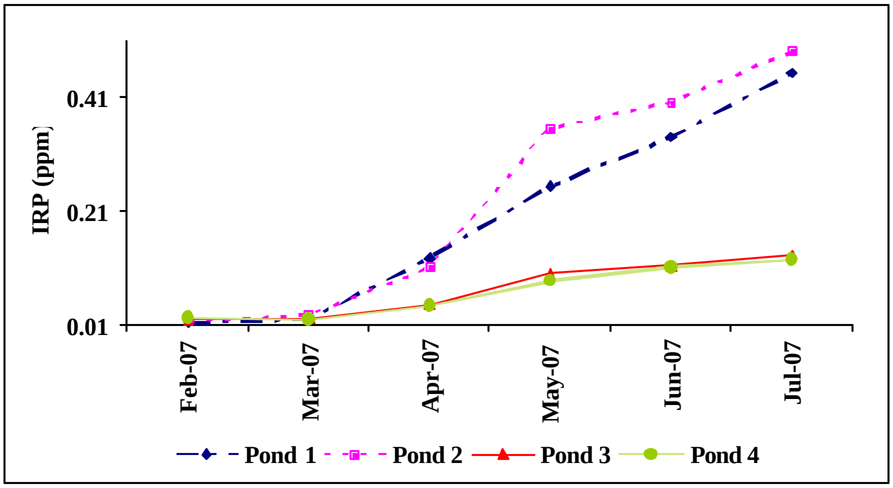

Fig. 7: Monthly variations of inorganic reactive phosphate in shrimp culture ponds

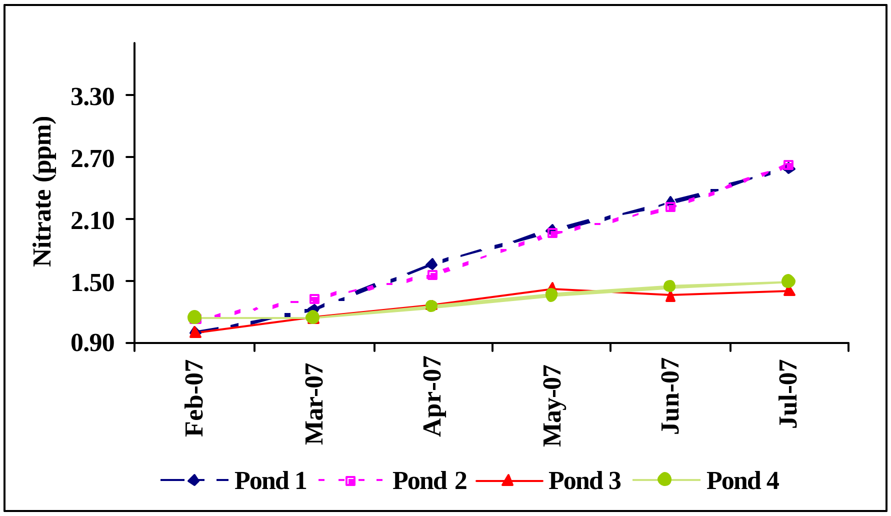

Fig. 8: Monthly variations of nitrate in shrimp culture ponds

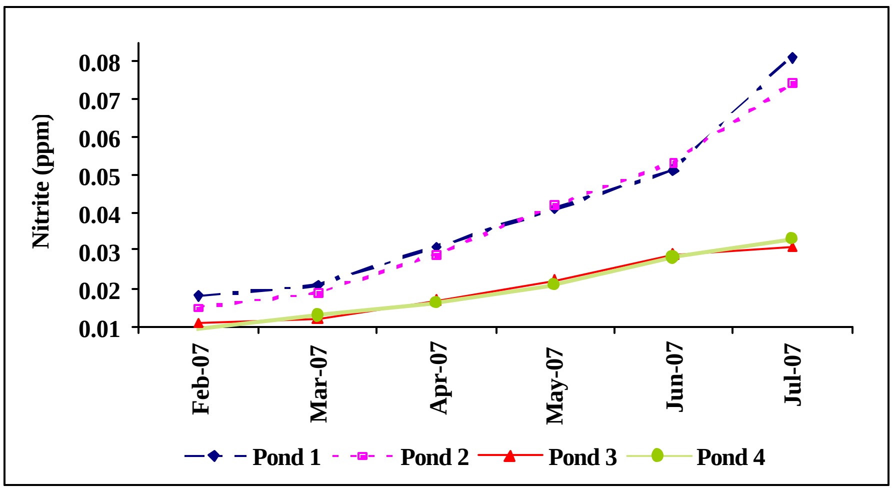

Fig. 9: Monthly variations of nitrite in shrimp culture ponds

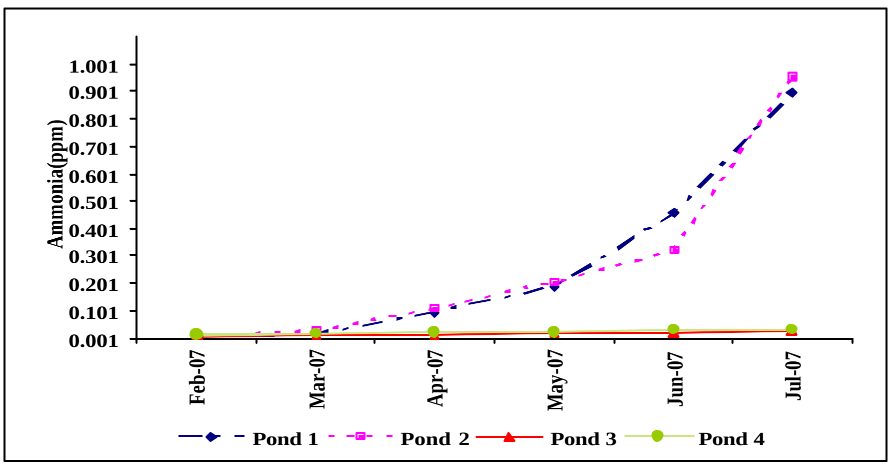

Fig. 10: Monthly variations of ammonia in shrimp culture ponds

farm reaches was the minimum of 32.4 ppt during the month of February at pond 4 and the maximum was of 38.8 during the month of July at pond 1. The pond 4 showed maximum transparency of 63 cm during February and minimum transparency of 43 cm during July. The pH at shrimp pond reaches varied from 7.7-8.5, while the minimum was recorded during the month of February and the maximum was recorded during the month of July. For Dissolved oxygen values in shrimp pond, it varied from 3.4 to 4.5 ppm at pond 2 and pond 4, the minimum was recorded during the month of July and maximum dissolved oxygen was in the month of February.

Inorganic reactive phosphate fluctuated with in the range from of 0.014to 0.492 ppm at all the ponds. The minimum value was recorded at pond 1 during the month of February and the maximum value was recorded at pond 2 during the month of July. The minimum Nitrate-nitrogen values of 1.13 ppm and maximum values of 2.62 ppm were recorded during the month of February and of July at pond 4 and 2, respectively. The Nitrite-nitrogen in the shrimp farm was ranged from 0.009 to 0.081 ppm, the minimum was recorded at pond 4 during the month of February and the maximum was recorded at pond 1 during the month of July. During the entire study period, the Ammonia-nitrogen showed well defined marked fluctuations and the range was observed from 0.011 to 0.956 ppm, the minimum was recorded during the month of February (pond 3) and the maximum (pond 2)value recorded during the month of July.

DISCUSSION

The maintenance of good water quality is essential for optimum growth and survival of shrimps. The levels of physical, chemical and biological parameters control the quality of pond waters. The level of metabolites in pond water can have an adverse effect on the growth. Good water quality is characterized by adequate oxygen and limited level of nutrients. Temperature is one of the most important environmental factors because it can affect an aquatic animal's metabolism, oxygen consumption, growth rate, moult cycle and survival rate directly. The optimum range of temperature for the black tiger shrimp is between 28 to 30°C [10]. In the present study the similar trend was observed in all the shrimp culture ponds.

Salinity is one of the important factors which profoundly influence the abundance and distribution of the animals in shrimp farm. Even though *P. monodon* is euryhaline animals it is comfortable when exposed to optimum salinity. At high salinity the shrimps will grow slowly but they are healthy and resistance to diseases [11]. The salinity of the present study was ranged from 32.8-38.8 ppt in the culture pond. The maximum salinity was occur in the pond of 1 and 2 shows 38.5 and 38.8 ppt this highest range of salinity could cause the reduction of optimum growth. Lack of freshwater availablelity, the farmers they couldn't exchange the water frequently in the farm. The inflow of fresh water and tidal flushing is scarce during summer hence the salinity reached a maximum during summer. The pH is one of the vital environmental characteristics, which decides the survival and growth of shrimp under culture; it also affects the metabolism and other physiological process of shrimps. The optimum range of pH 6.8 to 8.7 should be maintained for maximum growth and production [12]. The recommended pH of *P.monodon* culture was 7.5 to 8.5; in most common cause of high pH is high rate of photosynthesis by dense phytoplankton blooms. In the present study showed pH was ranged between 7.7- 8.5 for the culture pond. When pH is high water exchange will be better choice [13, 14].

Dissolved oxygen plays an important role on growth and production through its direct effect on feed consumption and maturation an also the low-level of oxygen tension hampers metabolic performances in shrimp and can reduce growth and moulting and cause mortality [15]. The dissolved oxygen in all the culture ponds in the present study was ranged between 3.4 to 4.5 ppm this could be support normal growth.

The transparency is mainly depends on the presence of phytoplankton. The secchi disc reading should be between 30- 40 cm. The optimum range of secchi disc reading is between 30 to 60 cm to the juvenile stage and between 25 to 40 cm to the sub adult and final stage [15].

The transparency of the present study is 43 to 63 cm. also observed similar transparencies (35-50 cm) for his study [15].

The availability of different forms of nutrients and their relative rates of utilization are important factors contributing to the relative success of algal bloom in the shrimp culture pond. Nitrogen and phosphorous content in shrimp farm were found to have an increasing trend with the increasing culture period [16]. Nitrogen is present in water in the form of ammonia, nitrite and nitrate. In the present study, the concentration of ammonia ranged from 0.011 to 0.956 ppm, ammonia is the main nitrogenous product excreted by crustaceans [17] nitrite ranged from 0.009 to 0.081 ppm. The pond 1and 2 showed high Ammonia level, this may the reason of reducing survival rate, when compare to the pond 3 and 4. The concentration of nitrate ranged from 1.13 to 2.62 ppm. Nitrate was slightly high when compare to the others. Towards the days of culture the nutrients also increased the concentration this may due to excessive feed and fertilizers in the pond [18]. In this study showed that the concentration of nitrate was slightly higher in the normal seawater; the same observation was made in shrimp farm [19].

In conclusion, the minimum growth rate and survival rate was occurred in pond 1 and 2 this might be due to the excess amount of salinity and ammonia was present in the culture period, but the normal growth was occurred in pond 3 and 4. *Penaeus monodon* do not grow well at very high salinity and temperature. Levels beyond the optimum affect shrimp growth and immune response. There is no solution to get good growth, perhaps the best solution is to harvest the shrimp once farmers observed that the shrimp are no longer growing to minimize economic loss due to unnecessary inputs like feed; and to look for alternate species that can tolerate high temperature and high salinities.

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