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Water quality assessment of pacific white shrimp *(Litopenaeus vannamei)* in semi-intensive culture systems at villages of Prakasam district, Andhra Pradesh, India

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Abstract
The present study was conducted to understand the Physico-chemical parameters *viz.*, Temperature, Salinity, pH, Dissolved Oxygen, Alkalinity, Hardness, Nitrite- Nitrogen, Nitrate-Nitrogen and Ammonia in 15 semi-intensive shrimp culture ponds (5 at Ananthavaram, 5 at Madanur and 5 at Pakala villages) of Prakasam district, Andhra Pradesh, India. Temperature ranged from 26.5 ºC to 28 ºC in the ponds. Low salinity (10.5ppt) was observed in Madanur ponds and high (39.0ppt) in Pakala ponds. pH varied from 7.56 to 8.7. Dissolved oxygen varied from 4.4 to 8.6 mg/l. Minimum values of dissolved oxygen were recorded at Madanur village pond and maximum in Ananthavaram ponds. The alkalinity was minimum (124mg/l) in the ponds of Pakala and maximum (230mg/l) in Madanur ponds. The hardness ranged from 2640 to 6722 mg/l. The nitrite-nitrogen was minimum (0.01) in Madanur ponds and maximum (0.80) in Ananthavaram ponds. The nitrate- nitrogen was minimum (2.48mg/l) in Pakala ponds and maximum (6.34mg/l) in Madanur ponds. The ammonia values were 0.02 to 2.0 mg/l.

Keywords: *Litopenaeus vannamei*, water quality management, shrimp ponds, Prakasam and Andhra pradesh

Introduction
India occupies the second largest aquaculture nation in the world with 10.79 million tons next to china [1]. The vast resources in terms of water bodies and species of fish and shellfish in different agro-ecological regions of the country provide for a wide array of culture systems and practices [2]. The shrimp, *Litopenaeus vannamei* is the major contributor to the overall aquaculture production in the country. It expanded rapidly across the country due to is growth rate, short culture period and high export value. However, the successful production of shrimp is often limited by physico-chemical factors of the water. It directly influences the productivity of shrimp farm and the ambient water in which shrimp lives has a cumulative effect on growth performance and survival of shrimp with respect to the production [3,4]. Proper water quality management plays a significant role to prevent the stress on shrimp that can accelerate them to various diseases [5]. Therefore, study of physico-chemical factors is the focal point of much research [6, 7]. Many researchers studied the water quality parameters in shrimp culture. Carpenter *et al.* (1986) [8] studied the effects of water quality and production of *P. monodon* in earthen pond. Saksena *et al.* (2006) [9] reported the limnology of Kharland (saline) ponds of Ratnagiri, Maharashtra in relation to prawn culture potential. Pushparajan and Soundarapandian (2010) [10] recorded the water quality parameters of the black tiger shrimp, *P. monodon* culture pond at Mamallapuram, Devaneri, Tamil Nadu. Janakiram *et al.* (2011) [11] reported the survival, growth, and *P. monodon* in modified-extensive and semi-intensive culture systems of Andhra Pradesh. Chakravarty e*t al.* (2016) [12] reported a spatial variation of water quality parameters of shrimp culture ponds at East Godavari district of Andhra Pradesh. Maintenance of water quality within the optimal levels during the culture period, especially in semi-intensive culture condition is very essential. Hence, the present study is aimed at assessing the water quality parameters such as temperature, salinity, pH, dissolved Oxygen, alkalinity, hardness, nitrite- nitrogen, nitrate-nitrogen and ammonia in fifteen shrimp culture ponds of Ananthavaram, Madanur and Pakala villages of Prakasham district Andhra Pradesh, India.

Materials and Methods
Water samples for the analysis were collected during June, 2017 from fifteen different shrimp ponds. Five from Ananthavaram village (A1, A2, A3, A4, and A5; 15°32’65” N; 80°30’90” E**)**, five ponds at Madanur village (M1, M2, M3, M4 and M5; 15°33’31” N; 80°09’83” E) and five at Pakala village (P1, P2, P3, P4 and P5; 15°24’38” N; 80°08’14” E) (Fig:1) of Prakasam district, Andhra Pradesh, India. Surface water temperature of different shrimp ponds was recorded between mornings to mid noon with the help of Mercury thermometer. Samples were collected in separate reagent bottles and analyzed at the laboratory for different parameters studied following the methods of APHA [13]. In case of dissolved oxygen, the collected water samples were fixed with Winkler’s A and B separately and further were analyzed at the laboratory.

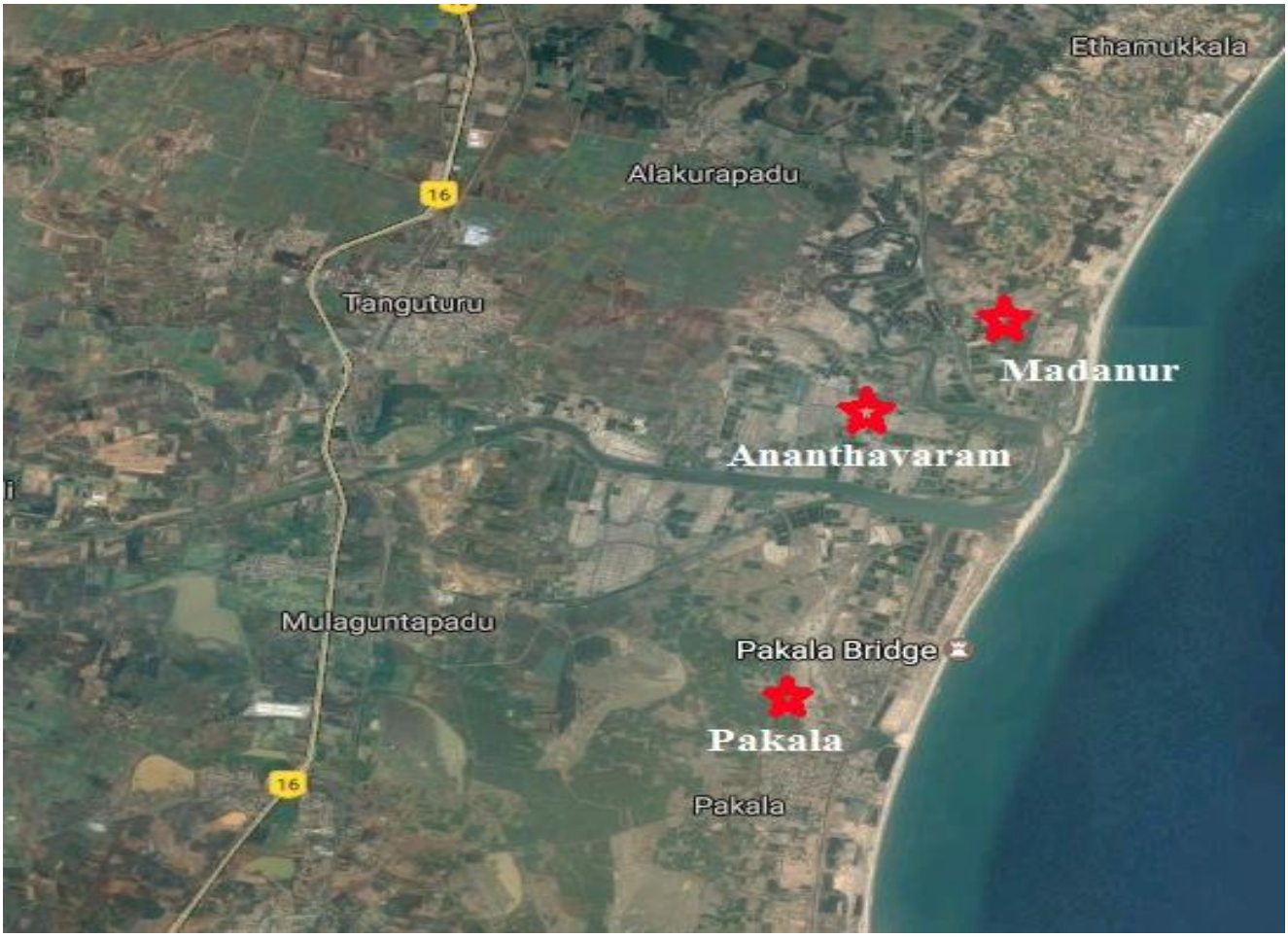

Fig 1: Study Area

Results

Temperature

Temperature was low (27 ºC) in pond A4 and A5 of Ananthavaram, M2 in Madanur ponds and P1, P3 and P4 ponds of Pakala village. High (28.5 ºC) temperatures were recorded in ponds A2 & A3 of Ananthavaram village (Fig. 2).

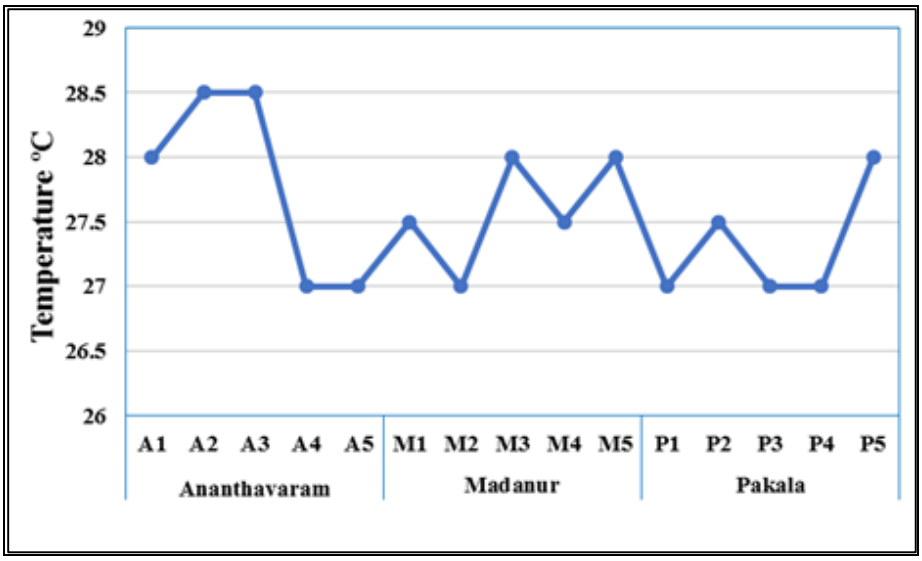

Fig 2: Temperature of pond waters at Ananthavaram, Madanur and Pakala villages.

Salinity

It ranged from 10.5 to 39.0ppt. The high salinity recorded at ponds P1 & P2 of Pakala and low at A1 & A2 ponds of Ananthavaram (Fig. 3).

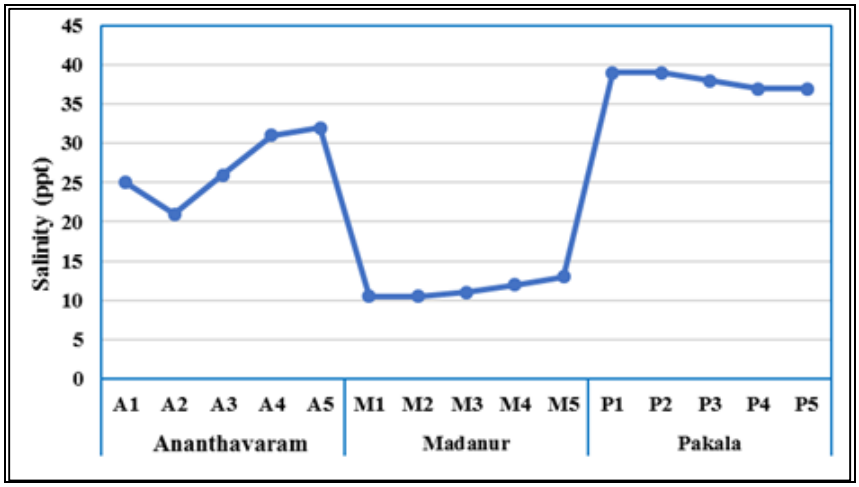

Fig 3: Salinity of pond waters at Ananthavaram, Madanur and Pakala villages

pH

pH ranged from 7.56 to 8.7 (Fig. 4). The low pH (7.56) was recorded at pond P4 and high (8.7) at pond A4 of Ananthavaram village.

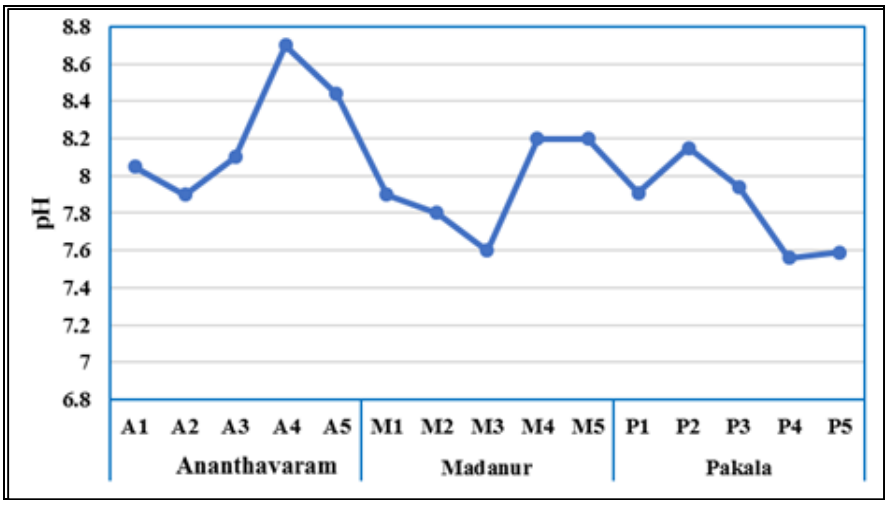

Fig 4: pH of pond waters at Ananthavaram, Madanur and Pakala villages.

Dissolved oxygen

Dissolved oxygen varied from 4.5 to 8.6 mg/l (Fig. 5). Minimum was recorded in the pond M5 of Madanur village and maximum in pond A1 of Ananthavaram village.

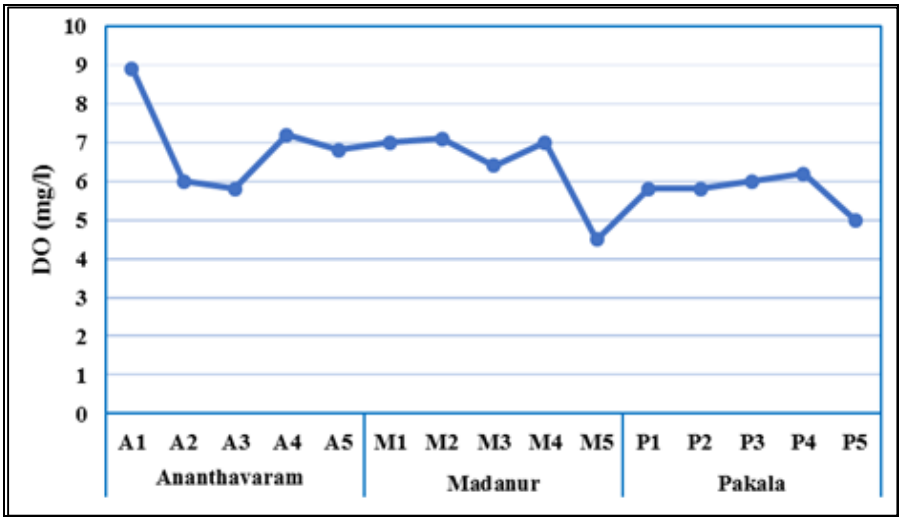

Fig 5: Dissolved oxygen of pond waters at Ananthavaram, Madanur and Pakala villages.

Alkalinity

The alkalinity was minimum (124mg/l) in pond P5 of Pakala and maximum (230mg/l) in M4 pond of Madanur village (Fig. 6).

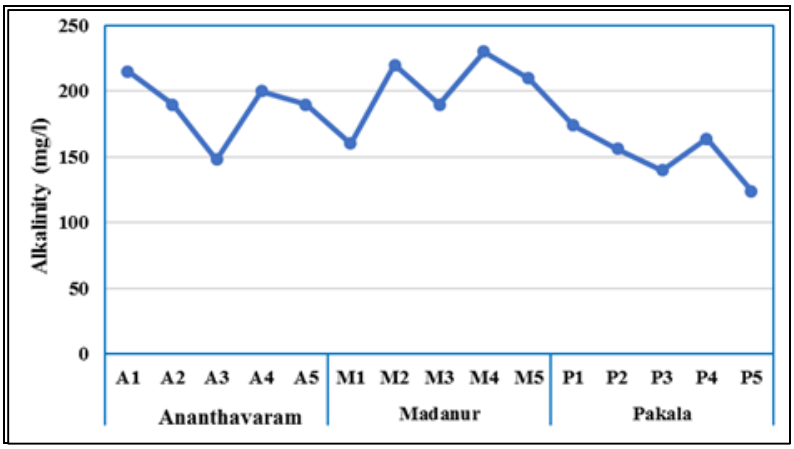

Fig 6: Alkalinity of pond waters at Ananthavaram, Madanur and Pakala villages.

Hardness

The total hardness in shrimp ponds of Ananthavaram village is varied from 4300mg/l to 6400mg/l. Minimum was recorded in pond A3 and maximum in pond A4 & A5. In Madanur village, minimum hardness of 2640mg/l was observed in pond M2 and maximum of 3670mg/l in pond M3. At Pakala village, low hardness (6425mg/l) was observed at pond P5 and high (6722mg/l) in pond P1 (Fig. 7).

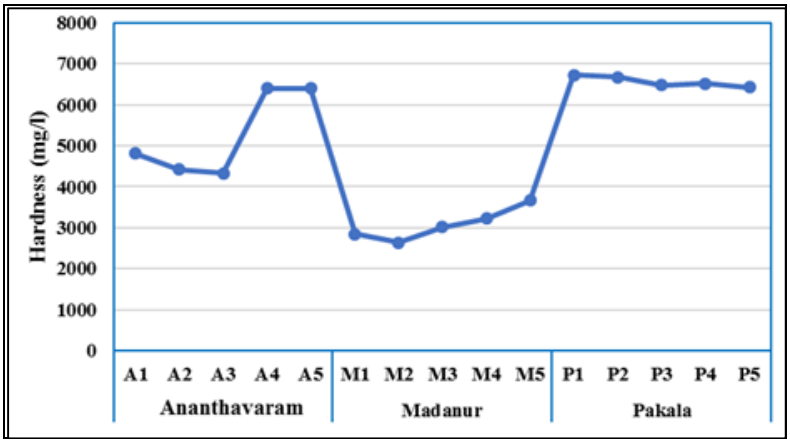

Fig 7: Hardness of pond waters at Ananthavaram, Madanur and Pakala villages.

Nitrite- nitrogen

The nitrite-nitrogen was minimum (0.01mg/l) recorded in pond M5 of Madanur and in Pond P5 in Pakala. The maximum (0.80mg/l) in pond A2 of Ananthavaram village. The nitrates were absent in the shrimp ponds A5 of Ananthavaram village and ponds P1 & P3 of Pakala (Fig. 8).

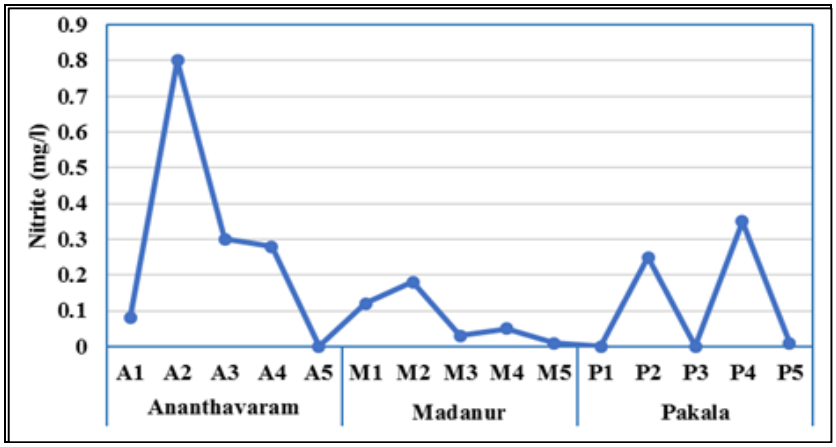

Fig 8: Nitrite- Nitrogen of pond waters Ananthavaram, Madanur and Pakala villages

Nitrate- nitrogen

The nitrate-nitrogen was minimum (2.48mg/l) in pond P3 of Pakala village and maximum (6.34mg/l) in pond M4 of Madanur village (Fig. 9).

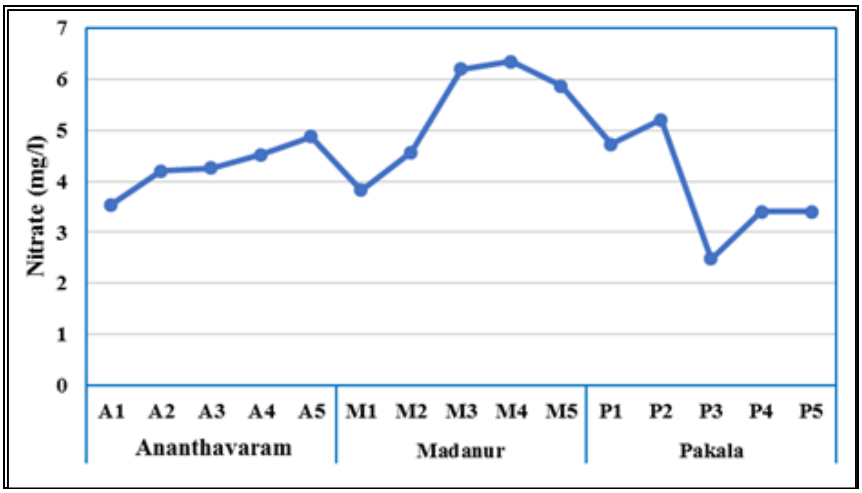

Fig 9: Nitrate- Nitrogen of pond waters at Ananthavaram, Madanur and Pakala villages.

Ammonia

The ammonia of shrimp ponds ranged from 0.02 to 1.07mg/l. In Ananthavaram village minimum recorded at pond A1 and maximum in pond A4. M2 & M3 ponds of Madanur were recorded high (2.0mg/l) ammonia whereas low (0.04 mg/l) in M1. In Pakala the minimum (0.02mg/l) was observed in pond P2 and maximum (0.76mg/l) in pond P4 at Pakala village. The ammonia was completely absent in pond A5 of Ananthavaram village (Fig. 10).

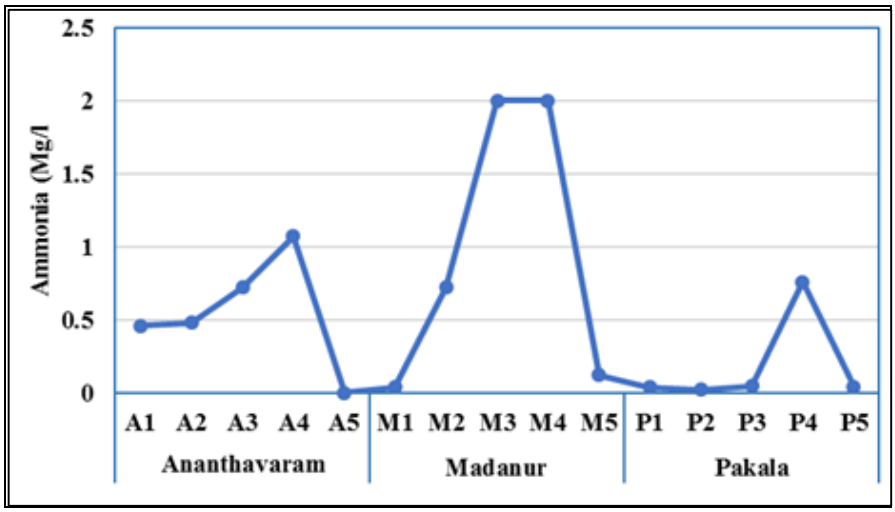

Fig 10: Ammonia of pond waters at Ananthavaram, Madanur and Pakala villages.

Discussion

Shrimp culture gaining more importance due to its unique taste, high nutritive value and persistent demand in domestic as well as in the export markets. The physico-chemical parameters of water play crucial role in the culture systems. Management of water quality parameters in shrimp culture ponds has been essential for optimum growth and viability of shrimp. Variation in the water quality parameters beyond a particular range will definitely have its impact on production. Temperature is one of the most important factors which influence the physiological responses in the organisms like respiration, metabolism, growth and reproduction [14]. It has pervasive controlling effect on penaeid shrimp growth [15, 16]. The cultured shrimp grows best in a temperature ranges from 24-32 ºC [17]. During the study, temperature was recorded between 27.0 to 28.5 ºC. *L. vannamei* is a euryhaline species it can tolerate the wide range of salinity between 10.5 to 39ppt [18, 19]. Several works have reported that the optimal range of salinity required for good growth and survival ranges from 10-35ppt [20, 21]. Salinity is a direct influence on the survival, growth and production of *P. monodon* in culture ponds [22, 23, 24]. In the present study, the salinity was observed among the ponds ranged from 10.5-39.0ppt. In pond water, the pH is influenced by source of water and acidity of soil. The pH of the present study varied from 7.56 to 8.70ppt. The permissible limit of pH in shrimp culture is 7.5 to 8.5 [25, 26]. The level of dissolved oxygen in pond water depends on the production of phytoplankton and also weather conditions are influenced dissolved oxygen concentration. The dissolved oxygen lethal for *L. vannamei* is reported 1.0 ppm in culture pond conditions [27]. The dissolved oxygen content ranged from 4.4 to 8.9ml/l. Pankaj Kumar *et al.* [28] have observed the

positive correlation between temperature and salinity, salinity and primary productivity, primary productivity and dissolved oxygen, dissolved oxygen and nitrate, nitrate and total available phosphorous at four stations of shrimp ponds in Patelwadi village. Alkalinity is the buffering capacity of the water. It can affect the primary productivity and also the water pH. In the present investigation, the alkalinity level 124 to 230mg/l. The hardness of water in the present study showed a variation between 2640 to 6722mg/l which is out of the favourable limits. Nitrite represents the intermediary form by the conversion of ammonia to nitrate. Generally, the high concentration of nitrite is uncommon in aquatic systems [14]. High nitrite concentrations commonly deactivate haemoglobin in the blood crustaceans [29]. However, blood of shrimp does not contain haemoglobin. Therefore, instead of haemoglobin, the oxygen binds to copper at the gills of the shrimp and delivered throughout the body and cause effect on the circulatory and immune system of aquatic organism [30]. In the present study, the nitrite-nitrogen levels were recorded from 0.01- 0.80. For the culture of *L. vannamei*, the optimal levels of nitrite concentration is < 1.0mg/l [31]. Nitrate is an inorganic nitrogen compound formed at end of the nitrification process. The concentration of nitrate is usually higher when compared to ammonia and nitrite. High levels of nitrate will give effect to the osmoregulation and oxygen transport of the culture aquatic species [29]. In addition, high concentration of nitrate also contributes the eutrophication and excessive growth of algae in the culture pond. Clifford (1994) [31] suggested that the favourable concentration of nitrate-nitrogen for *L. vannamei* is 0.4 - 0.8mg/l. The observed values of nitrate-nitrogen are 2.48 to 6.34, which shows higher range. The total ammonia has ranged between 0.02 to 2.0mg/l which is within the ideal limits of the water quality parameters [25]. Varadaraju *et al.* [32] have found that the water and soil properties of the ponds were within the optimal limits required for shrimp culture and the correlation between soil and water quality parameters namely pH, dissolved oxygen and temperature were that significantly affecting the shrimp production. Hassan *et al.* [33] have found higher dissolved oxygen, salinity, ammonia, nitrite-nitrogen, phosphates and are significantly higher in sampling stations inside culture ponds of mafia Island, Tanzania. Diu. Devi *et al.* [34] have suggested ill effects caused by imbalance in the water quality and soil of ponds for survival of aquatic animals are to be and monitored and controlled. The studies on physico-chemical characterization of shrimp culture ponds have confirmed with the earlier observations [35, 12].

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