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A study on water quality parameters in shrimp *L. vannamei* semi-intensive grow out culture farms in coastal districts of Andhra Pradesh, India

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Abstract
Shrimp aquaculture especially *Litopenaeus vannamei* farming in India is became promising growth rate for the past decade. Andhra Pradesh costal districts are playing key role in India's shrimp production. The present study was conducted at *L. vannamei* cultured ponds, located at various coastal districts of Andhra Pradesh state, India, where shrimp farming was practicing large scale level in semi-intensive culture systems of brackish water aquaculture. The aim of the study was to determine the beneficial role played by the water quality parameters in *L. vannamei* culture pond. A total of 4 districts Guntur, Krishna, West Godavari and East Godavari were selected out of 13 districts of newly formed Andhra Pradesh state for the present study and a total of 320 *vannamei* culture farms were selected from all four districts both randomly and purposively and 80 *vannamei* farms were selected from each district. The study was conducted during the period of February to June 2019 (summer crop) shrimp farms and water samples collected and analysis were carried as per the procedures of APHA[1]. A total of 10 water quality parameters such as temperature, salinity, pH, total alkalinity, total hardness, calcium hardness, magnesium hardness, total ammonia, nitrites, and dissolved was measured. The results showed that majority *L. vannamei* farmers were maintaining optimum water quality in their shrimp culture ponds, some parameters had shown slight deviation (Table: 2) compared with the optimal water quality values (Table: 1). As the water quality were maintaining at optimal levels and the discharged water is safe and non-hazardous to the natural environment. The maintenance of optimal water quality parameters could be attributed to the implementation of Better Management Practices (BMP's). The present study concluded good water quality parameters management in all the *vannamei* culture farms help the Better Management practices (BMPs) to produce healthy, good survival, growth and production of *L. vannamei* shrimp by brackish water aquaculture from coastal Andhra Pradesh of India.

Keywords: Water quality, aquaculture, shrimp farming, water parameters, BMPs

1. Introduction
Brackish water aquaculture is one of the fastest-growing food sectors in the world. Amongst the various branches of aquaculture, shrimp culture has expanded rapidly across the world because of the faster growth rate of shrimps, minimum culture period, more export value and demand in the market. In developing countries of east and Southeast Asia, shrimp aquaculture has become an important industry and contributes to the majority of the export both in terms of quantity and value. Currently, more than 70 % of global shrimp production is coming from Asian countries and most of the produced shrimp are exporting to earn foreign exchange and economic development of the countries. India is one of the leading producer of farmed shrimp in the world. Although shrimp cultivation has an important contribution for the export earnings but still there's a space for improvement in total production through lateral growth and Better management Practices (BMPs). In this regard, the state of Andhra Pradesh has the high productive shrimp producing brackish water aquaculture area in India, and it can be for its suitability for the wide expansion or development of the shrimp aquaculture.
Water quality plays an important role in increasing the productivity of the pond. It provides nutritionally a balanced and healthy environment to cultured animals [2] Sediment and water quality has a significant role in increasing the total production of the pond. However, in India, much fewer efforts have been made to assess the role of these parameters in the productivity of shrimp farms, and it necessitates attention for further research. Water quality management is important in aquaculture quality of the pond water is one of the main factors for the success of

the shrimp aquaculture as shown in the (Table.1). The physical and chemical characteristics of pond water are very much influenced by the properties of bottom soil sediment. The bottom soil sediment provides food and shelter to the shrimp in culture pond environment and also act as the reservoir of nutrients for the growth of microalgae which constitute natural food for the aquatic organisms [3, 4]. Physical and chemical factors like temperature, salinity, total suspended solids (TSS), dissolved gases and nutrients influence the water quality directly or indirectly, which ultimately govern the healthy survival of organisms in the aquatic ecosystem and also salinity plays an important role in the physiological functions of culture organisms. The hydrogen ion concentration in water (pH) and pond bottom soils can play a major role in the health, survival, and growth of aquatic animals, the balance of salt and water during a tissue is extremely essential for maintaining the coordination in its metabolic (Physiological) functions of the organisms.

Table 1: Optimum Water quality parameters for shrimp *L. vannamei* culture

S. No	Water Quality Parameter	Optimum range	Measuring unit
1	Salinity	12-25	PPt
2	pH	7.5-8.5	0-14
3	Alkalinity	>120	PPm
4	Total hardness	>1000	PPm
5	Calcium hardness	>150	PPm
6	Magnesium hardness	>450	PPm
7	Total Ammonia Nitrogen	<1.0	PPm
8	Nitrite	<0.5	PPm
9	Hydrogen sulfide	<0.01	PPm
10	Dissolved Oxygen	>4	PPm

Water quality problems resulting from high stocking, increased feeding rates and intake of polluted water are increasingly common in shrimp farming. Good water quality directly influences shrimp growth, survival and overall production. Poor water quality- causes disease, mortality, slow growth and low production of shrimp. The discharge of pond water effluent is another activity associated with environmental degradation in the receiving waters [5].

2. Objective of the study

The Present research study was carried out with the objective to study the water quality parameters of selected shrimp ponds. Information gathered from the study would be useful to understand the productivity of the shrimp culture ponds with reference to water characteristics during the summer crop (Feb-June 2019).

3. Materials and Methods

3.1 Study area

The present study was conducted during (summer) February-June 2019. The newly formed Andhra Pradesh has 13 districts with 974km of the coastal line among them four coastal districts Guntur, Krishna, West Godavari and East Godavari districts were selected for the present study.

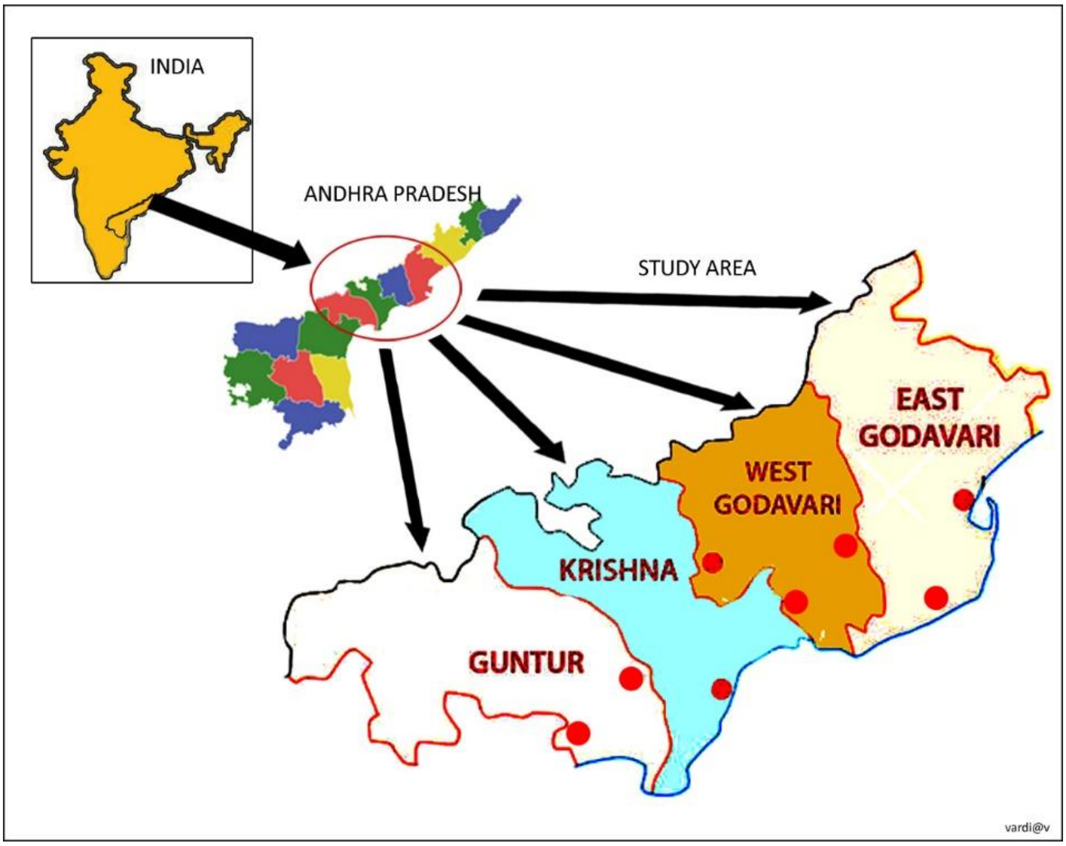

Fig 1: Andhra Pradesh map (Study area districts)

The four districts were selected based on the farming practices of the shrimp *L. vannamei* farms adopted the Better Management Practices (BMPs), registered by CAA Coastal Aquaculture Authority, Department of Fisheries (DoF) Andhra Pradesh. 80 ponds were selected from the each district for the present study.

Table 1: Study area in 4 districts of Andhra Pradesh.

S. No	Name of the Study area	No. of Villages covered	No. of Farms covered	Total culture area covered (Ha)
1	Guntur	8	80	189
2	Krishna	12	80	239
3	West Godavari	9	80	205
4	East Godavari	8	80	201

The areas of the selected shrimp ponds ranged from 0.5-4 ha with average pond depth ranges from1-1.5 meter, selected ponds that are similar with respect to stocking densities, feeding, and other management inputs.

3.2 Method of water samples collection

The water sample was collected between 6-7 am in all selected culture ponds by dipping 500ml clean polythene bottles 1-2 feet depth in the ponds and samples were brought to the laboratory for analysis of various chemical parameters like Salinity, pH, total alkalinity, total hardness, calcium, magnesium, total ammonia, nitrate, dissolved oxygen by standard methods according to APHA [6].

3.3 Method of Analysis

3.3.1 Temperature

Water temperature was measured with a mercury-filled Celsius thermometer ranging 0 to 50 °C. To measure temperature the thermometer was dipped in to the water for one minute and the stable temperature final reading was recorded.

3.3.2 Salinity

Salinity of the collected water samples was measured using a digital refractometer model Seawater Analysis HI96822 Hanna instruments. The salinity probe was immersed in the water samples to be tested without exceeding the maximum immersion level and waited for the salinity reading, and the final salinity value was recorded.

3.3.3 pH

Water pH of the collected samples was measured using a digital pH meter (edge® blu Bluetooth® Smart pH Electrode and Meter - HI2202 HANNA instruments) nearest to 0.01. Before using the instrument it was calibrated with pH 7 and pH 10 buffer solutions. The pH probe was immersed in the water samples to be tested without exceeding the maximum immersion level. Then the sample was stirred gently and waited for the reading to stabilize and the final pH reading was recorded.

3.3.4 Alkalinity

Alkalinity of the water was measured using titration method following (APHA, 1992). The burette was first rinsed with distilled water and then rinsed with 0.1N Sulphuric acid (H_2SO_4) was standardized by Na2CO3 solution. 10 ml sample was taken in a 250 ml conical flask and added 5 drops of the phenolphthalein indicator solution into it. 5 drops methyl orange indicator was added to the sample and titrated with 0.1N sulphuric acid (H_2SO_4) to a light pink color and the volume of titrate was recorded. Alkalinity of the sample was determined by calculating with following formula.

$$\text{Alkalinity, mg/L } CaCO_3 = \frac{A \times N \times 50{,}000}{\text{mL of Sample}}$$

3.3.5 Hardness

Hardness of water was measured using Ethylenediaminetetraacetic acid (EDTA) titration method.

0.800M ethylene di-amine tetra acetic acid (EDTA) titration cartage was set into the selected place of the titrator. By moving the knob of the titrator the liquid was taken at the end of the delivery tube. Then the reading was taken of the titrator at 0.10 ml sample water was taken and 90 ml distilled water was taken into the 250 ml conical flask and 2 ml of buffer solution was taken (Hardness-1) into the sample water. Titration was done with 0.800M ethylene di-amine tetra acetic acid (EDTA) until the color change from red to blue. Titration was carefully done at the end point and the temperature was kept under 200 ^{0}C. Total hardness was calculated with the following formula:

$$\text{Hardness of EDTA as } CaCO3/L = \frac{AxBx1000}{\text{mL of Sample}}$$

3.3.6 Calcium (Ca)

Calcium of collected water samples was measured using test kit AA 222 AA biotech Calcium kit.

3.3.7 Magnesium (Mg)

Magnesium of collected water samples was measured 5ml of hydroxylamine hydrochloride, 4 ml of polyvinyl alcohol, 5ml of 0.05% thiazole yellow, and 3.5 ml of 10N caustic soda are added to 30 ml of the neutral solution containing 30-200 mg of magnesium. The solution is allowed to stand for 15min at 25±0.5° and calorimetrically is carried out at 540 nm.

3.3.8 Total Ammonia

The ammonia of collected water samples was measured using 50 ml of sample add with 2 ml of phenol solution, 2 ml of sodium nitroprusside, 5 ml of oxidizing solution mix well. Allow to stand for one hour at the 200c-270c cover with Aluminum foil, read at 640 nm in a spectrophotometer.

3.3.9 Nitrite (NO_2)

Nitrate of collected water samples was measured 50 ml of sample add with 1ml of sulphonamide, allow to 2min add 1ml of NNED allow to Stand for 10 min read at 540 nm.

3.3.10 Dissolve oxygen (DO)

Dissolve oxygen (DO) of collected water samples was measured using a digital DO meter (Portable Dissolved Oxygen meter - HI8043 HANNA instruments). The probe plug was connected into the probe input socket and the power button was pushed. Then the O^2 screw was turned on and waited for the reading and final DO reading was recorded.

4. Results and Discussions
Water quality is one of the important factors in the determination of shrimp farm culture activity success.in shrimp ponds water quality is influenced by both environmental and management practices. The result analysis (Mean±SD) of the water quality parameters in shrimp *L. vannamei* culture ponds of Guntur, Krishna, West Godavari, and East Godavari districts in Andhra Pradesh was shown in Table. 2

In Shrimp ponds Water exchange is a management tool for that is intended to reduce organic and solid loadings in shrimp pond; if water exchange is not being practiced or is significantly reduced it could be expected that the concentrations of solids, nutrients, and organic matter would increase in the pond system. There are other environmental characteristics that might influence water quality, these are the nature and condition of the pond bottom, aeration level, lime applications, feeding rate, and stocking density.

Table 2: Water quality parameters (Mean ±SD) in selected shrimp ponds from Guntur, Krishna, West Godavari and East Godavari districts in Andhra Pradesh, during summer crop (Feb-June 2019)

S. No	Name of the Parameter	Units	Guntur (Mean±SD)	Krishna (Mean±SD)	West Godavari (Mean±SD)	East Godavari (Mean±SD)
1	Temperature	°C	28.62±2.78	27.18±2.42	24.47±1.86	24.97±2.19
2	Salinity	PPt	24.46±3.85	25.74±2.93	16.66±2.97	13.43±3.77
3	pH	0-14	7.86±1.2	7.88±1.4	7.67±1.5	7.91±1.4
4	Total Alkalinity	PPm	137±41.51	146±16.45	139±13.78	142±16.62
5	Total Hardness	PPm	5109.61±586.39	5408.82±538.45	3517.48±498.74	3089.39±466.58
6	Calcium	PPm	896.51±131.5	886±149.8	346±112.7	537±106.4
7	Magnesium	PPm	1024±163	1032±176	998±101	1001±112
8	Total Ammonia	PPm	0.9±0.06	0.8±0.07	1.1±0.09	1.0±0.04
9	Nitrite	PPm	1.14±0.09	1.12±0.08	1.10±0.05	1.09±0.07
10	Dissolved Oxygen	PPm	5.37±1.09	5.44±1.05	5.78±1.19	6.16±2.89

4.1 Temperature
Temperature is an essential parameter to influence the photosynthesis in water, physiological responses of culture organisms and decomposition of organic matter and subsequent biochemical reactions. It is also one of the most important factors controlling the growth of marine shrimp [7] a significant seasonal variation in the water temperature has been noticed among all the culture ponds from February to June due to the onset of summer. The high temperature will cause the high organic load formation and increase the bacterial loads in the culture ponds, during the study temperatures was noticed lowest 24.47±1.86 °C and highest 28.62±2.78 °C in the shrimp ponds due to high temperature (Table:2). Dissolved oxygen DO dissolving rate will increase in the pond water and it causes some physiological stress to the animal in the ponds.

4.2 Salinity
Salinity is an important parameter to increase the growth and survival of the brackish water aquaculture. The salinity was maintained lowest 24.47±1.86ppt and highest 28.62±2.78ppt in the study area (Table:2) due to summer season salinities are raised more, optimum salinity ponds area shows good growth and survival compared to other ponds. In high salinity, the shrimps will grow slowly but they are healthy, active and resistance to diseases.

4.3 pH
pH is an important parameter to control the growth and survival of shrimps. pH is vital environmental characteristics and it also affects the metabolisms and other physical process used to reduce soil acidity. The pH was maintained lowest 7.67±1.5 and highest 7.88±1.4 (Table: 2) the most common cause of high pH is a high rate of photosynthesis by dense phytoplankton blooms. The pH in the shrimp culture ponds is affected by the water alkalinity, pond soil pH, lime applications and phytoplankton bloom activity.

4.4 Alkalinity
Alkalinity plays a major role in shrimp culture ponds because of its involvement in the shrimp molting process. Low Alkalinity leads to broad pH variations which result in reduced growth and even mortality in shrimp. High alkalinity levels may stop the process of shrimp molting due to excess salt loss. It also has indirect effects on primary productivity in the pond. In the present study, all total alkalinity was noticed lowest 137±41.51 ppm and Highest 146±16.45 ppm (Table: 2) maintained within the optimum ranges with slight variations.

4.5 Total hardness
Total hardness (Calcium and Magnesium) are essential nutrients for the shrimp. Calcium functions to minimize the rise in PH when photosynthesis rates are high. Hardness in all culture ponds was ranged from 3089.39±466.58 to 5408.82±538.45 observed (Table: 2).

4.6 Calcium (Ca)
Calcium is essential for the bones formation, shell formation of the crustaceans in the brackish water aquaculture calcium hardness ranges from lower is 346±112.7 and higher 896.51±131.5 was observed (Table: 2).

4.7 Magnesium (Mg)
Magnesium is essential for the development of natural plankton in water also mineral balance in the animal body plays a crucial role for the growth and development of the shrimp ranges from 998±101 to 1032±176 observed (Table: 2).

4.8 Total Ammonia
Ammonia is the main end-product of protein catabolism in crustaceans and can account for 40% to 90% of nitrogen excretion [8]. In the present study noticed that ammonia levels 0.8±0.07ppm in lower ranges and 1.1±0.09 ppm higher

observed (Table: 2). Many of the farmers are careful about their culture ponds to maintain good water quality using pond care products weekly to lowering the ammonia levels in the ponds. Ammonia concentrations in water can be observed due to increase ammonia excretion by aquatic organisms diminishes, and levels of ammonia on blood pH and adverse effects on enzyme-catalyzed reactions and membrane stability. Ammonia increases oxygen consumption by tissues, gills, and reduces the ability of blood to transport oxygen. In water, ammonia may be derived from microbial metabolism of the nitrogenous compounds under low oxygen condition. Ammonia exists in water in both ionized (NH4) and unionized (NH3) forms. Unionized ammonia in aquaculture ponds is more harmful form of ammonia due to its ability to diffuse readily across cell membrane the fraction of NH3 depends on pH, temperature, and to a lesser extent on salinity [9]. As pH or temperature rises in the pond water, NH3 increases relative to NH4, and the toxicity of ammonia to animals, increasing pH level in a given ammonia solution could increase the ammonia toxicity to shrimp postlarvae.

4.9 Nitrites (NO_2)
Nitrites are formed through the nitrification process is oxidation of NO2 by the action of aerobic bacteria. It is generally stable over a large range of environmental conditions and highly stable in water. Nitrite, an intermediate product during the two-steps oxidation of ammonium through the highly aerobic, gram-negative, chemoautotrophic nitrifiers such as Nitrosomonas and Nitrobacter, is occasionally accumulating in aquaculture systems and can be toxic to aquatic animals. Nitrite is routinely found in intensive pond aquaculture systems because large amounts of nitrogen are added in the form of formulated feed, fertilizer, or manure. Although it appears that most of the nitrite found in aquaculture is derived from the nitrification process, there is evidence that nitrite in aquaculture ponds may be derived from de-nitrification of nitrate in the bottom mud. Nitrite may also accumulate in water after sudden increases in ammonia concentrations following phytoplankton die-off. Boyd and Tucker stated that decomposition of the dead plant material releases large amounts of ammonia into the water. The increased availability of ammonia stimulates the activity of ammonia-oxidizing bacteria, and nitrite is produced. In the present study, Nitrites ranged 1.09±0.07ppm to 1.14±0.09ppm (Table: 2). these values should be lowered otherwise they will affect the cultural species.

4.10 Dissolved Oxygen (DO)
Dissolved Oxygen plays an important role in growth and production through its direct effect on feed consumption and maturation. Dissolved oxygen affects the solubility and availability of many nutrients in the pond water. Low level of dissolved Oxygen can cause damages in the oxidation state of substances from the oxidized to the reduced form lack of dissolved oxygen can be directly harmful to shrimps and cause a considerable increase within the level of hepatotoxic metabolic performances in shrimp and can cut back growth and molting and cause stress its leads to mortality. The dissolved oxygen in all the culture ponds in the present study was ranging from 5.37±1.09 ppm to 6.16±2.89ppm (Table: 2).

5. Conclusion
A sufficient supply of good quality of water is essential to any aquaculture cultivation operation. The criteria for good quality water vary with the kind of organisms and are established by safe levels, i.e., physical and chemical properties of water which have insignificant adverse effects on shrimp growth and survival. The factors dominant the composition of pool water square measure very varied and include physical, chemical and biological processes. To keep water properties within safe levels, one must understand those processes so that the elements inhibiting prawn growth and survival can be detected and their impact minimized. The aims of water management are to provide high-quality water and minimize water quality fluctuations. The main approaches to achieve optimal culture environment are to reduce organic load, maintain the system in a highly oxidized state, conduct proper water exchange, and maintain a stable phytoplankton community. The major method to avoid sudden mass mortality of phytoplankton is to keep the phytoplankton from reaching the peak of its reproductive cycle. It is worthy to know plant ecology and notice indicator species for the water quality. Circulation aeration is a must in semi-intensive and intensive culture systems. They promote production. The aim of water exchange is to change the water so that water quality does not change abruptly. A combination of inorganic fertilization, aeration, water exchange, and waste removal and application of water probiotics once in a week can be most efficient in managing water quality. It is necessary for the environmental and shrimp culture researcher to control the ill effects caused by an imbalance in the quality of water and soil of shrimp ponds for the survival of aquatic animals. So the present study has helped to formers and researchers for their future studies to improve the growth and productivity of shrimps. The study concludes that the maintenance of optimal water and soil quality parameters in all the *L.vannamei* culture systems helps the environmentally friendly practices of shrimp aquaculture in India.

6. Conclusion
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