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STUDIES ON CULTURE PRACTICES OF *PENAEUS VANNAMEI* (BOONE, 1931) AND *PENAEUS MONODON* (FABRICIUS, 1798) FROM BHIMAVARAM, ANDHRA PRADESH

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ABSTRACT: The present study aimed on the culture practices of two shrimp species *P. vannamei* and *P. monodon* from the culture ponds at Bhimavaram, Andhra Pradesh. Pond preparation, water quality parameters, stocking, survival, growth, feed, FCR, biomass and disease management were observed during the study period. The stocking density of *P. vannamei* was high when compared to *P. monodon*. ABW was in the range of 27.77 to 1.25 g in *P. vannamei* whereas 47.61 to 58.82 g in *P. monodon*. Highest biomass was found to be 10,653.12 and 6762.66kg in *P. vannamei* and *P. monodon* respectively. ADG and FCR were 0.57 and 0.66g; 1:1.4 and 1:1.38 in *P. vannamei* and *P. monodon* respectively. The present work revealed that these two species are tolerable to fluctuations in water quality parameters and are best suitable for aquaculture practices.

Key words: Culture practices, water quality parameters, *P. vannamei*, *P. monodon*

INTRODUCTION

India is endowed with a long coastline of 7516.6 km and offers scope for large exploitation of marine wealth. The estimated potential brackish water area is about 1.20 million hectare spread across the coastal states of Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha and West Bengal. Among the coastal states, West Bengal and Andhra Pradesh are the largest producers of *P. monodon* and *P. vannamei* shrimp respectively in the country, today *P. vannamei* is the largest cultured shrimp in terms of production and productivity in India. The country currently have 176,000 hectares of area under shrimp culture out of which about 91% is under *Litopenaeus vannamei* production, 8% for *Penaeus monodon* and only 1% for *Macrobrachium Rosenbergii* [Global Aquaculture Alliance, 2020], Shrimp production can be increased by best utilizing the existing resources through improved practices of shrimp culture [Eenadu, 2020, Khshbu, 2022]. 1,08,526.27 ha is under *L. vannamei* culture in 9 maritime states producing 8,15,745 MT with Andhra Pradesh leading in total area under culture and production followed by Gujarat and Tamil Nadu during 2020-21. During the year 2022, the state of Andhra Pradesh had the highest production over 782,000 MT in India. All India average productivity is 7.52 MT/ha/Year. Andhra Pradesh shares the largest producer of shrimp in the country with 634672 MT during 2020-21 (MPEDA). The nine farming states have produced 27,616 MT of black tiger shrimp in the year 2021 with West Bengal topping the production followed by Kerala and Andhra Pradesh (MPEDA). 58196 ha of area are under *P. monodon* culture (MPEDA).

Brackish-water aquaculture in India is concentrated around giant prawn *P. monodon* as the single most important species.White-leg Shrimp, *P. vannamei* however, has attracted the farmers' attention because of its fast growth, low incidence of native disease, availability of Specific Pathogen Free (SPF) domesticated strains and culture feasibility in wide salinity range. Recently *P. vannamei* culture has also started in fresh water ponds particularly in Telangana and some other states in India by stocking PLs acclimatizing to zero salinity at hatchery level. The culture and production levels are encouraging. With the development of shrimp culture practices from traditional form to modern intensive culture practice, the complexity of diseases has been equally magnified in India. The frequent outbreaks of diseases in shrimps are causing economic loss of around 15-25% to the aquaculture industry. The viral outbreaks are minimal in low saline waters compared to high saline waters with the best management practices. The share of brackish-water sector includes culture of shrimp varieties mainly the native giant tiger prawn, *Penaeus monodon* and exotic white leg shrimp *Penaeus vannamei*. Risk analysis was carried out by the Central Institute of Brackish water Aquaculture (CIBA) and National Bureau of Fish Genetics and Resources (NBFGR) with the aim of evaluating the feasibility of introduction of this new species (Srinivas and Venkatrayalu, 2013). The fisheries sector plays significant role in Indian economy contributing to 0.91% to national GDP and 5.23% to the agricultural GDP (NFDB, 2020).

Black tiger shrimp is mostly farmed in the traditional ponds of West Bengal, Odisha and Kerala, whereas the exotic *P. vannamei* variety is farmed mainly in the states like Andhra Pradesh, Gujarat, Tamil Nadu and Odisha. Indian shrimp especially enjoys very good demand in all major overseas markets. Despite prevailing anti-dumping duty on frozen shrimp, India remains the largest supplier of the item to the US and Japan markets. Nowadays Indian shrimps are getting exported to China and Russia. Currently in shrimp farming practices, *P. vannamei* is most widely cultured species, due to its inherent capabilities like disease resistance, can sustain to higher temperature, adoptable to wide range of salinities and frequent water fluctuations. Soundarapandian and Ramanan (2010) investigated the effect of probiotics on the growth and survival of *P. monodon*. Balakrishnan et al., (2011) reported the survival and growth rates of *P. vannamei* against various stocking densities' levels. In most of aquaculture sectors brackish water preferred for the culture of penaeid shrimp species. The purpose of the present study is to estimate the growth, survival rate and diseases of *P. vannamei* and *P. monodon*.

MATERIALS AND METHODS

STUDY AREA

The present work was done in the culture at Thaderu, Bhimavaram, West Godavari district of Andhra Pradesh (16.5159°N, 81.5439°E) during Dec 2021 to Feb, 2022. The farm has total 78 acres of area under culture, of which 50 acres was for *P. vannamei* culture and 28 acres for *P. monodon* culture and contains 6 sections namely (A,B,C,D,E,F). All ponds from C-section were chosen for the study which contained six ponds (C1-C6). And only four sections for *P. monodon* (A1,B1,C1,D1) with regard to *P. monodon* also the C1 section with four tanks (C7-C10) was taken. During the study period pond preparation, bio-security, stocking, water quality parameters, feeding patterns, feeding, FCR, sampling, check tray management techniques were undertaken.

POND PREPARATION

Disinfection of the pond was done by using sodium hydroxide flake at the rate of 5kg per acre. The sodium hydroxide flake is dissolved in 12 tons of water and is sprayed on the surfaces of the dried pond. The bottom of newly developed and excavated pond is treated with high dose of lime at 400-500 kg/hectare. The pond bottom is allowed to dry and crack to promote the capacity of the hydrogen sulphide (H_2S) and to eradicate micro and macro-organisms and other predators. The scraping of pond bottom is made up to 3-4 inches. The scraping black soils are removed and thrown away from the pond (Plate 1). Then the pond bottom is thoroughly ploughed at a depth of 30 cm to remove the gases existing in the soil. Then the pond bottom is treated with lime as well as bleaching powders. Generally quick lime and agricultural lime are used by the farmers, but burnt lime is more effective (Zadeh et al., 2010, Jagadeesh et al., 2022).

Plate 1: Drying and scraping of the pond

The saline water is entered to pond through pumping after fine filtration system up to 4ft-6ft water level. The filled water was treated with chlorine at 20ppm-30ppm and left for one week. The aerators are also allowed to run to circulate the water all over the pond. The pond water was conditioned with minerals, probiotics, locally prepared organic juices etc. before stocking. The pond is left for 3–4 days to allow for natural food (plankton) development, with water mixed by paddle wheel aerators (Khushbu et al., 2022).

WATER SOURCE

The main water source for cultural operations was underground water having a salinity of 7ppt. The underground water was pumped by using a 7.0 Hp motor into the reservoir where the water is treated with minerals and probiotics. Water from this reservoir was pumped into the culture ponds through the PVC pipe inlet (Plate 2).

Plate 2: Bore water pump

BIOSECURITY

Bio-security measures are of immense importance in shrimp farming to protect the stock from diseases. Bio-security measures are of physical, chemical and biological. Biological measures are stocking specific pathogen free (SPF) shrimp seed. Physical measures are installation of bird fencing and crab fencing as shown in Plates 3 and 4. Bird fencing over the pond to prevent the entry of birds and crab fencing on the dyke was done to prevent the entry of crabs, which acts as major carriers. Chemical measures are those treating the instruments with potassium permanganate (2ppm) and iodine (0.5ppm), hand dip treatment and foot dip treatment were followed before entering into the ponds.

Plate 3: Crab Fencing

Plate 4: Bird Fencing

ELECTRICITY

Availability of relatively cheap and reliable power source is a major consideration in site selection. In areas where electricity supply exists, it is practical and beneficial to utilize electric power to run the farm, especially for the intensive culture system. It is advisable to have a back-up electricity generator as a secondary power source.

STOCKING

P. vannamei post larvae (PL 10) and *P. monodon* post larvae (PL 15) were procured from Sri Gnaneshwari Hatcheries, Ongole and Sri Muktheshwara Hatcheries, Gudur respectively. After quality and PCR tests, the larvae were transported from hatcheries to culture ponds by the road services. The stocking of post larvae were undertaken after proper acclimatization process (Plate 5) (Jagadeesh et al., 2022).

Plate 5: Stocking of PL

STOCKING DENSITY

The stocking densities of *P. vannamei* post larvae were 1.75 lakh per acre and *P. monodon* post larvae were 48 thousand per acre. Compared with *P. vannamei*, P. *monodon* have less stocking densities because they are bottom organisms and are also lazy to move. If *monodon* is stocked at high densities a fungus "*gibbertella persicaria*" attacks the shrimps.

FEEDING

All the farms used formulated commercial pellet shrimp feeds from various companies for routine feeding purposes. Maximum number of farms adopted a combination of broadcasting (Plate 6) and check tray method (Plate 7) as feeding strategies regularly which was also adopted in the present study. The daily feeding timings was adjusted as per the check tray observations. Generally feeding is given 4 times a day (Table 1). After stocking, up to one month the larvae are given blind feeding. Various feed supplements are applied along with pellet feed and fed to shrimps for promotion of growth, avoiding loose (or) soft shell diseases etc. (Tables 2 and 3).

Plate 6: Broadcast Feeding

Plate 7: Check Tray Feeding

Sampling was done at regular intervals of time and the individual weights of the shrimps, average body weight, survival, Feed Conversion Ratio and Biomass of the animals were estimated. The recorded values were tabulated.

Average Body Weight % (ABW) = $\frac{Final\ weight - Initial\ weight}{Initial\ weight}\ X\ 100$

Average daily growth (ADG): $\frac{Average\ body\ weight}{Days\ of\ culture}$

Survival Rate (%) = $\frac{No.\ of\ animals\ survived}{No.\ of\ animals\ stocked}\ X\ 100$

Biomass = $no.of\ shrimps\ present\ in\ the\ pond\ X\ Average\ wt.of\ shrimp$

Feed Conversion Ratio (FCR) = $\frac{Feed\ intake\ (given)}{Wet\ weight\ gain}$

CHECK TRAY OBSERVATION

Check trays also known as feed trays or umbrella nets were placed on the pond bottom away from the wet slope and aerators. A pond of 1 hectare size requires 4-6 check trays. Check tray observations were used to estimate the amount of feed consumed by the shrimp, mortality and health of the shrimp which enters into the check tray**.** The amount of feed given in the check tray is based upon the days of culture (DOC) and average body weight.

WATER EXCHANGE

Water level was maintained from 1.0 m to 1.3 m throughout culture period by adding water to pond through pumping from near saline creek due to evaporation losses or seepage losses etc.

AERATION

1 hp- 3 hp aerators are used in the culture pond according to culture area, density, farm size, in the different corners of the pond. The aerators are under operation around 8-12 hours per day during entire culture period. Paddle wheel aerators are provided per pond to create water from the accumulation of wastes in the centre of the pond and to increase the dissolved oxygen in the water column. Aerators are placed 5 m away from the dyke and almost 10 m distance from each other.

WATER AND SOIL TREATMENTS

After stocking, soil and water probiotics, minerals, zeolites, ammonia reducer compounds, DO enhancer compounds, water disinfectants are widely used in the pond water periodically in regular intervals based on the water and soil quality conditions of the farm and shrimp health. The pond bottom sediments turns black colour (sludges) with increasing culture days and increasing rate of feeding dose. The sludge formation is controlled in pond by applying sludge digesting probiotic products and by using sludge motors.

Water quality parameters like Dissolved Oxygen (DO), Salinity, pH, Alkalinity, Hardness, Nitrite-nitrogen (NO_2-N), Nitrate-Nitrogen (NO_3-N) and Ammonia-Nitrogen (NH_4-N) were analyzed using DO meter, Refractometer (Salinometer), pH test kit, alkalinity test kit, hardness test kit, Nitrite test kit, nitrate test kit and ammonia test kit respectively.

SAMPLING

Weekly sampling was done to know the shrimp health, growth and survival. The first sampling has been carried out in all ponds at the 60 days of culture onwards. During sampling the growth and survival of the shrimp has varied depending on the stocking density. Sampling has been undertaken in the pond fortnightly during early hours of the day with cast net after 60 days of culture. Four to five hauls are made in each pond. The individual weight of each shrimp is observed.

GROWTH AND SURVIVAL

The average shrimp body growth rate is in the range of 27-31 gm in 47 days of culture with survival of 87-97%. The final shrimp production rate ranges from 12 ton to 24 ton/ hectare depending on the stocking density, growth rate and percent of survivals.

HARVEST AND MARKETING

Shrimps are harvested by the drag nets in most of the ponds. The harvested shrimps were packed with ice in trays after proper washing in fresh water. The shrimps are sold according to the count and size.

FERTILIZERS AND APPLICATIONS

The pond must be fertilized with either organic or inorganic fertilizer to stimulate the plankton bloom in order to provide shade to the pond bottom and utilize the nitrogenous and phosphate wastes within the pond. The shade will also prevent the growth of harmful benthic algae. The sun dried chicken manure is the most common organic fertilizer used at the rate of 200-300 kg/ha. The manure must be soaked in water for 24 hours before it is spread over the surface of the water.

Inorganic fertilizers, such as urea (46% N) and compound fertilizers like, ammonium phosphate (16:20:0) or those with N:P:K combination of (16:16:16) were used at 20-30 kg/ha. The fertilizer must be dissolved in water before it is spread over the water surface to avoid precipitation of the fertilizer onto the pond bottom, which will enrich the soil and accelerate the growth of benthic algae. After fertilization, the plankton should bloom within a few days and the color of the water becomes slightly green. The fertilizer, either the organic or inorganic, should be applied daily in the pond at 5-10 % of the initial amount to maintain the plankton bloom. If the plankton has not bloomed within a few days, additional fertilizer must not be applied, but plankton rich water or green water from the reservoir should be added. Certain chemicals and probiotics were added to the pond to improve growth, immunity and feed utilization (Tables 2 and 3).

Table 1: Feed chart during the culture period

D.O.C	Feed No.	Feed type	Body weight(g)	Feed (%)	Check tray g/kg	Check tray Timing(hrs)	Time of feeding
1-7	1C	Crumbled	0.01-0.09	-	-	-	4times
8-14	1C+2	Crumbled	0.09-0.80	-	-	-	4times
15-21	2	Crumbled	0.80-1.6	-	-	-	4times
22-28	2+2P	Crumbled	1.6-3	-	-	-	4times
29-35	2P+3S	Crumbled + Pellet	3-4	5.4-4.6	3	2	4times
36-42	3S	Pellet	5-6	4.4-3.8	4	2	4times
43-49	3S+3SP	Pellet	7-9	3.8-3.4	5	2	4times
50-56	3SP	Pellet	10-12	3.3-3.2	5	2	4times
57-63	3SP+3P	Pellet	12.5-15	3.2-3.0	6	2	4times

64-70	3P	Pellet	15-17.5	3.0-2.9	6	1.45	4times
71-77	3P	Pellet	17.5-20	2.8-2.5	8	1.45	4times
78-84	3P+4S	Pellet	20-23	2.5-2.3	8	1.45	4times
85-91	4S	Pellet	23-25	2.3-2.1	10	1.45	4times
92-98	4S+4M	Pellet	25.0-26	2.1-2.0	10	1.45	4times
99-112	4M	Pellet	26-30	2	10	1.3	4times
113-120	4M	Pellet	>30	1.8	10	1.3	4times

Note: This feeding chart is prepared for 1,00,000 shrimps. Feed quality to be adjusted based on moulting, environmental condition and feed intake of the shrimps by using feeding trays.

Table 2: Chemicals and additives used during the culture period

Name of the chemical	Composition	Dosage	Benefits
Vinalic	Pre biotic Enzymes organic acid	10-20mg/kg after 30 doc	
Beta- sim	Nucleotide, amino acid, vitamins, minerals	5-10g/kg	Immune response, muscle growth, feed consumption
Aqua-pro	*Bacillus subtilis*, Bacillus sp,. Enzymes: protease, Amylase, lipase,cellulase, Hemi cellulase, xylanase.	3-5g/kg	

Orex	Natural hepato protectants, Soluble protein, vitamins, Osmotic salts,enzymes	10-20g/kg	Improve gut absorption, Protects hepatocytes, recover Damage gut epithelium
Feedex	*Bacillus subtilis, Bacillus licheniformis, Lacto bacillus sporogenes, Streptococus faecium, Clostridium butericum*		Reduced digestive upset, inhibit vibrio and pathogens, improve, feed Utilization
Super-ps	*Nitrosomonas, Rhodococcus, Rhodo bacter, Nitrobacter.*	10-20ml/kg	Reduce H_2S gasses, reduce NH_3 levels, clean pond bottom
Llv-52 gel		20-25ml/kg	Growth promoter, h.p stimulant
Him-c	Vtamin C Na+ + K+		Growth, skeleton formation.

Table 3: Application of chemicals and additives (time and dosage) during the culture period

Application	Chemical	Time	Dosage
Moulting	Edta Mineral Probiotic	11-12 am 3pm 9am	1kg/acre 10 kg/acre 0.5kg/acre
pH(increase)	Limestone(caco3) Quik lime(cao+mg)	11-12pm 11-12pm	340kg/acre 40kg/acre
pH (decrease)	Jaggery+rice brawn+yeast	11-12pm	12:3:1/acre

Colour	Dolomite(ca.mg)co3) Jaggery+r.brawn+yeast	11-12pm 11-12pm	40kg/acre 16-20l/acre
Feed additives	Soyabean +yeast Him-c Feedex Vinalic Orex Zymix Lyxene Liv-52 Beta-sim Aqua pro	10-20ml/kg 5-10g/kg 5g/kg 10-20ml/kg 10-20g/kg 5g/kg 5g/kg 10-20ml/kg 5g/kg 5g/kg	

The penaeid shrimp *P. vannamei* exhibits fast growth rate (upto 3g/week and upto 20g under intensive culture conditions) and its culture period is significantly reduced compared to *P. monodon*. *P. vannamei* is amenable to high stocking densities (150/m^2 in pond culture and even as high as 400/m^2 in controlled recirculated tank culture), tolerate a wide range of salinities and temperature from 0.5 - 45 ppt and below 15°C, requires low protein feed (20-35%), has better feed conversion ratios (FCRs) of 1:2, 70-85% survival rate, availability of SPF seed, zero water exchange in the culture makes these species an alternative to *P. monodon* culture in several countries.

Results:

Water quality parameters:

The various water quality parameters were studied during the culture period. The DO values varied from 4.0-5.3 mg/L and 5.0-6.6 mg /L in *P. vannamei* and *P. monodon* respectively (Fig 1&2). pH ranged from 7.7- 8.2 in *P. vannamei* and 8.0-8.5 *P. monodon* (Fig 3&4). Salinity ranged from 7.0-9.6 ppm in *P. vannamei* and 8.25-10.0 *P. monodon* (Fig 5&6). Alkalinity was in the range of 128 to 284 mg $CaCO_3$/L in *P. vannamei* and 140 to 272 mg $CaCO_3$/L in *P. monodon* (Fig 7&8). Hardness ranged from 2066 to 2742 mg/L in *P. vannamei* and 1154 to 2568 mg/L in *P. monodon* (Fig 9&10). Ammonia (NH_3-N) content observed in shrimp farm waters was 0.02614 ± 0.3355 mg/L. Nitrite (NO_2) content observed in shrimp farm waters are 0.0555 ± 0.0956 mg/L. Nitrate (NO_3-N) content in shrimp farm waters was 0.0115 ± 0.0104 mg /L. Ammonia (NH_3-N) content observed in shrimp farm waters was 0.02614 ± 0.3355 mg/L. These ammonia contents found are still in the same limit for shrimp culture based on the ammonia (NH_3-N) content suggested by environment ministry namely < 1.0 mg/ L. Nitrite values are still in the same limit for shrimp farm based on the tolerance value recommended for shrimp culture namely < 0.25 mg/L.

Survival rate: In the present study low survival rate recorded was 93.6% in C3 pond whereas high survival rate of 97.4% was observed in C6 pond of *P. vannamei* (Table 4). Low survival rate of 87.2% was observed in C9 pond whereas high survival rate of 96% was observed in C7 pond of *P. monodon* during the culture period (Table 5).

Average body weight: The average body weight was recorded to be 27.77g in C2 pond and highest average body weight was recorded to be 31.25 g in C5 and C6 ponds of *P. vannamei* (Table 4). The average body weight was recorded to be 47.61 in C7 pond and highest average body weight was recorded to be 58.82 g in C10 pond of *P. monodon* during the study period (Table 5).

Average daily growth: The average daily growth recorded was 0.57 g in *P. vannamei* and 0.66 g in *P. monodon* during the study period.

Biomass: Highest biomass of *P. vannamei* was 10,653.12 kg in C6 pond (Table 4) and the highest biomass of *P. monodon* was 6762.66 kg in C10 pond during the study period (Table 5).

Feed Conversion Ratio (FCR): The FCR recorded was in the range of 1: 1.09 to 1:1.4 in *P. vannamei* (Table 6) whereas it was in the range of 1:1.33 to 1:1.38 in *P. monodon* during the study period (Table 7).

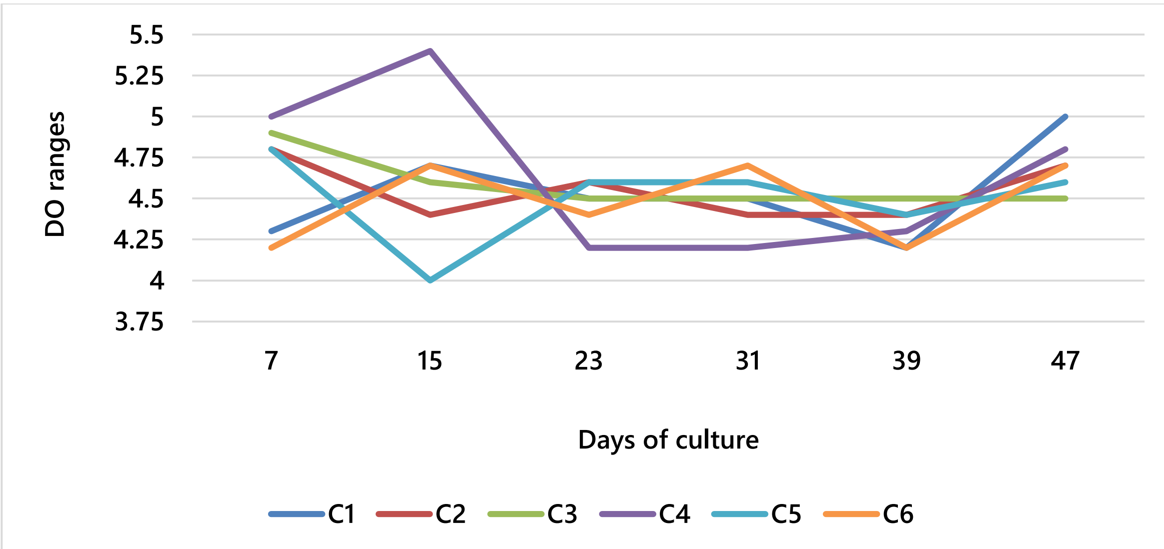

Figure 1: DO of *P. vannamei pond* during the study period

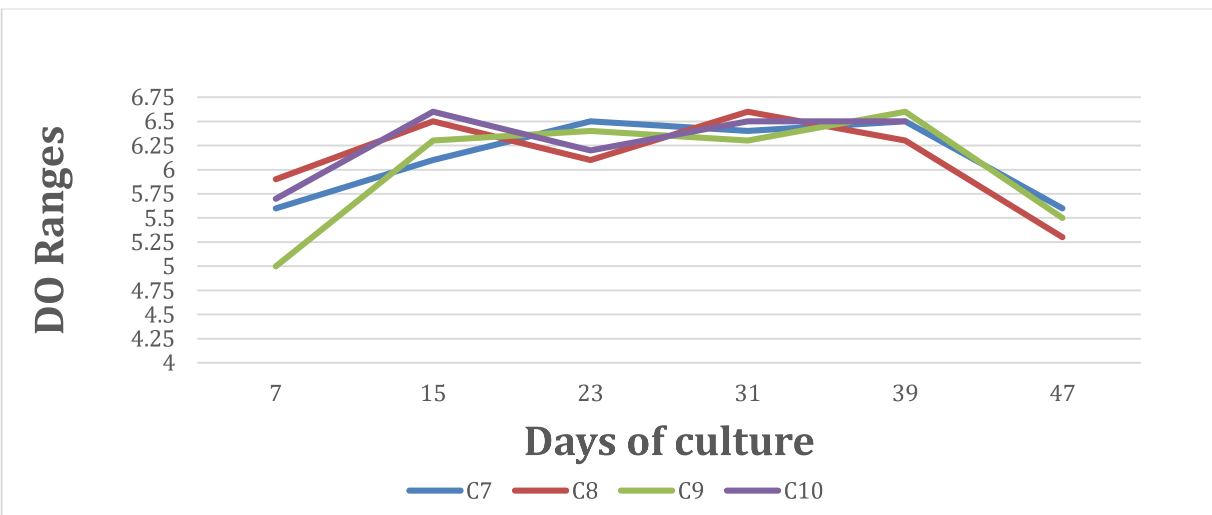

Figure 2: DO of *P. monodon pond* during the study period

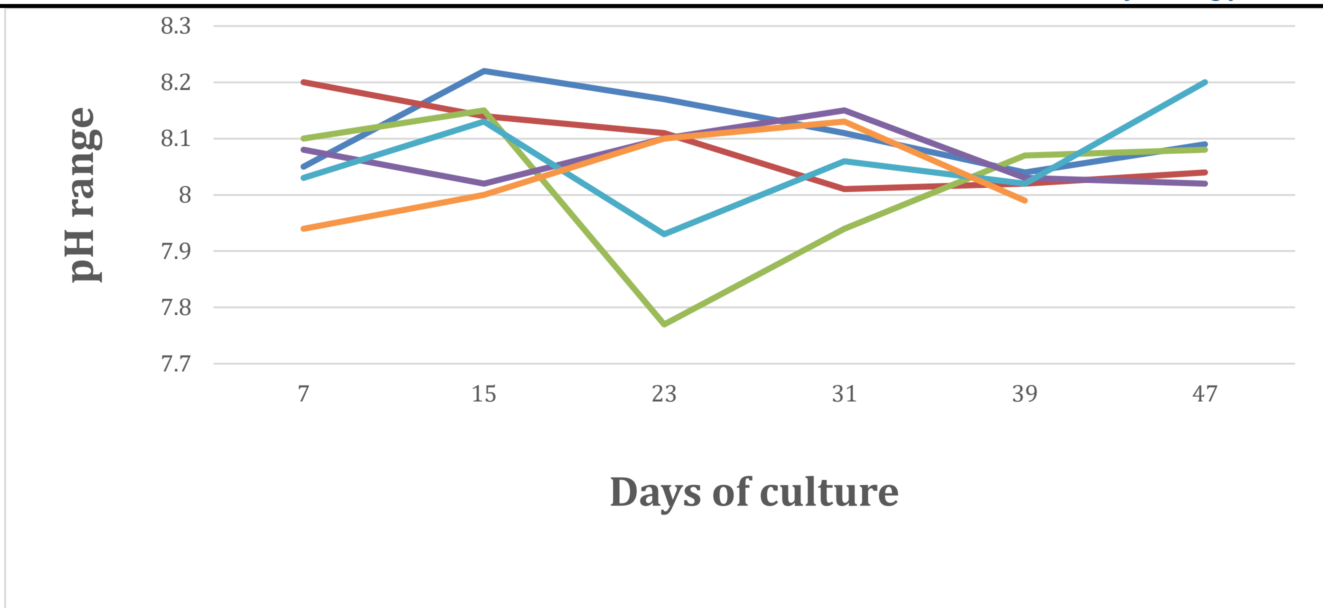

Figure 3: pH o *P. vannamei* pond during the study period

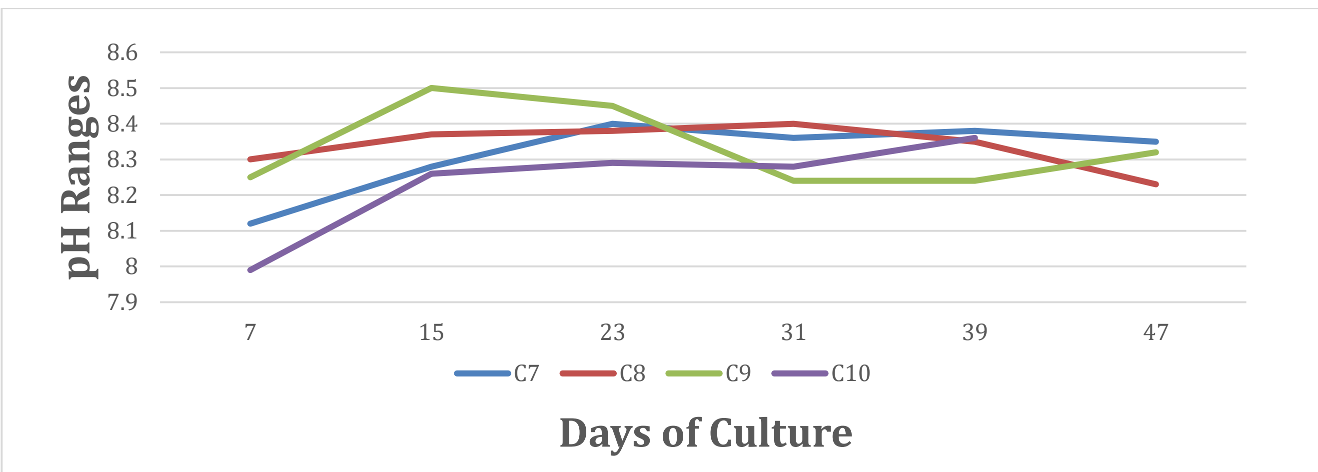

Figure 4: pH of *P. monodon pond* during the study period

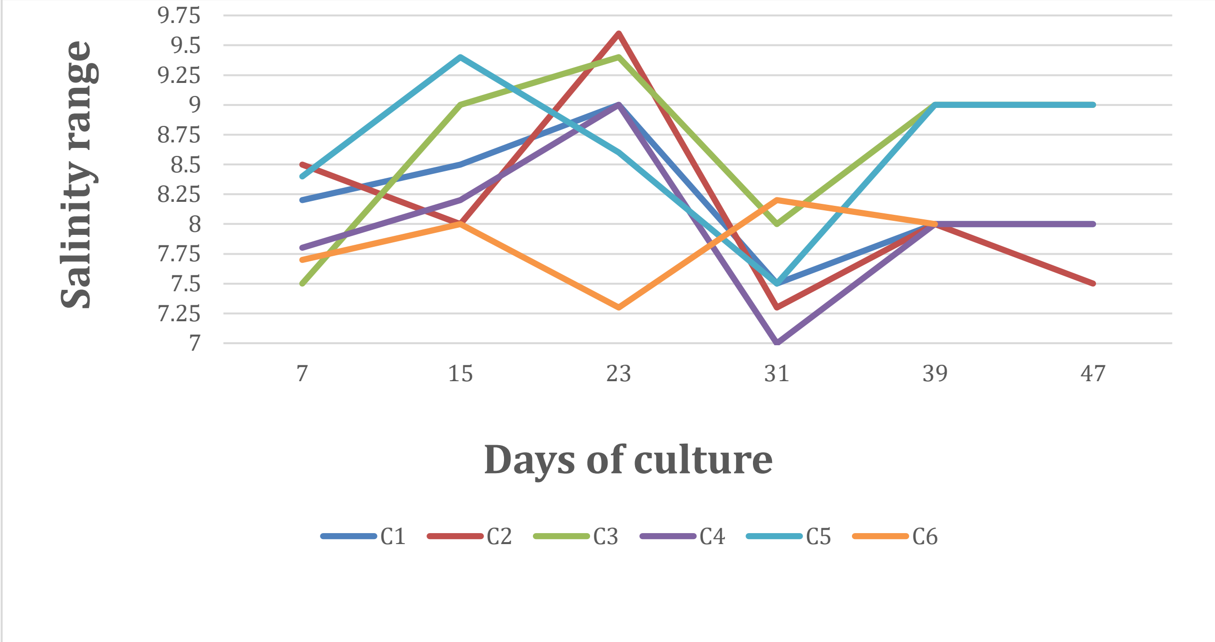

Figure 5: Salinity of *P. vannamei pond* during the study period

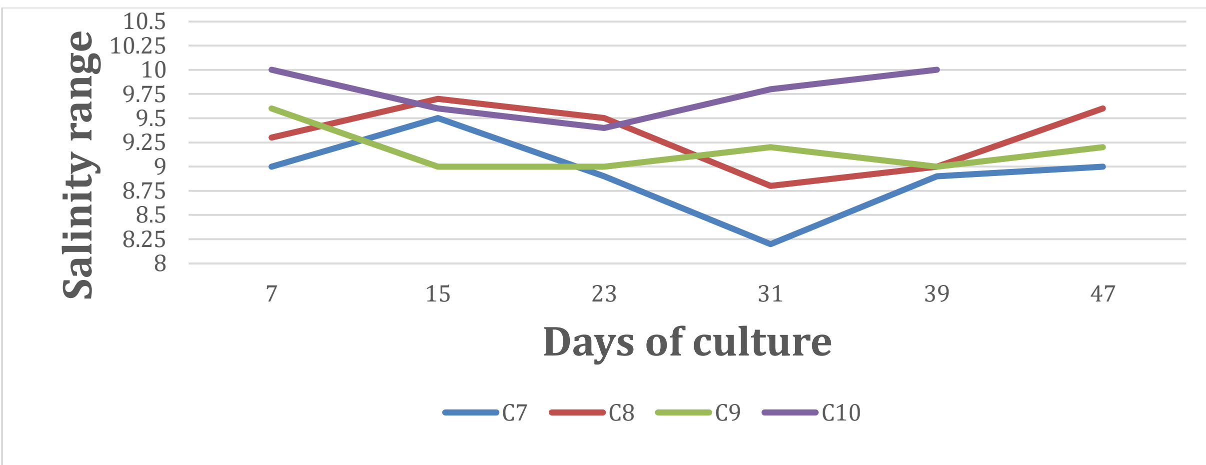

Figure 6: Salinity of *P. monodon pond* during the study period

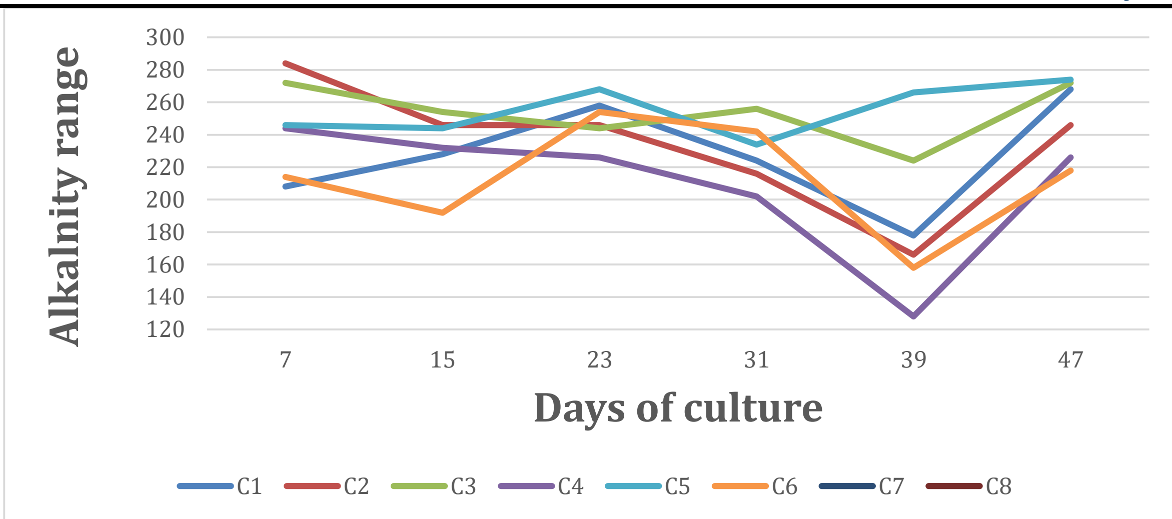

Figure 7: Alkalinity of *P. vannamei* during the study period

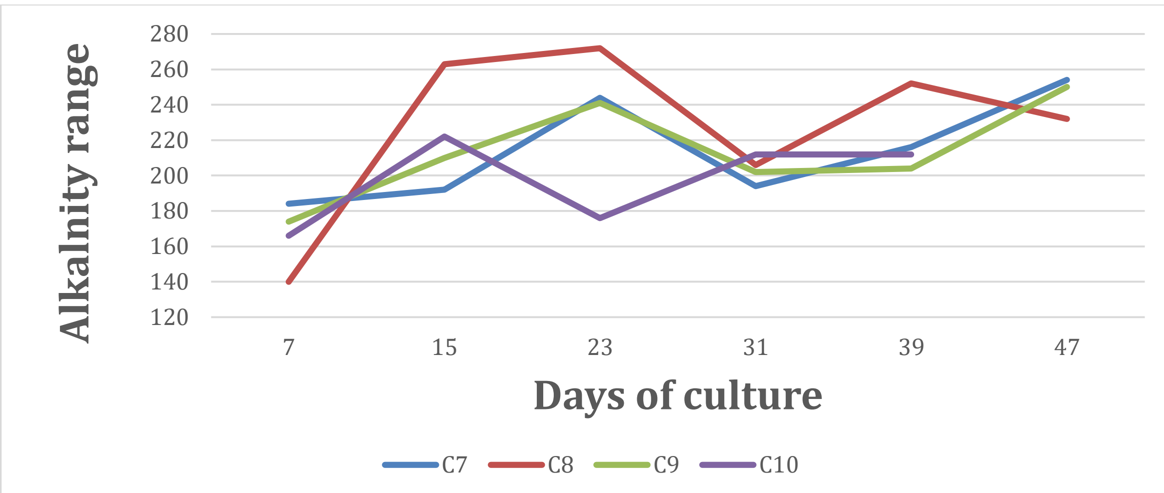

Figure 8: Alkalinity of *P. monodon pond* during the study period

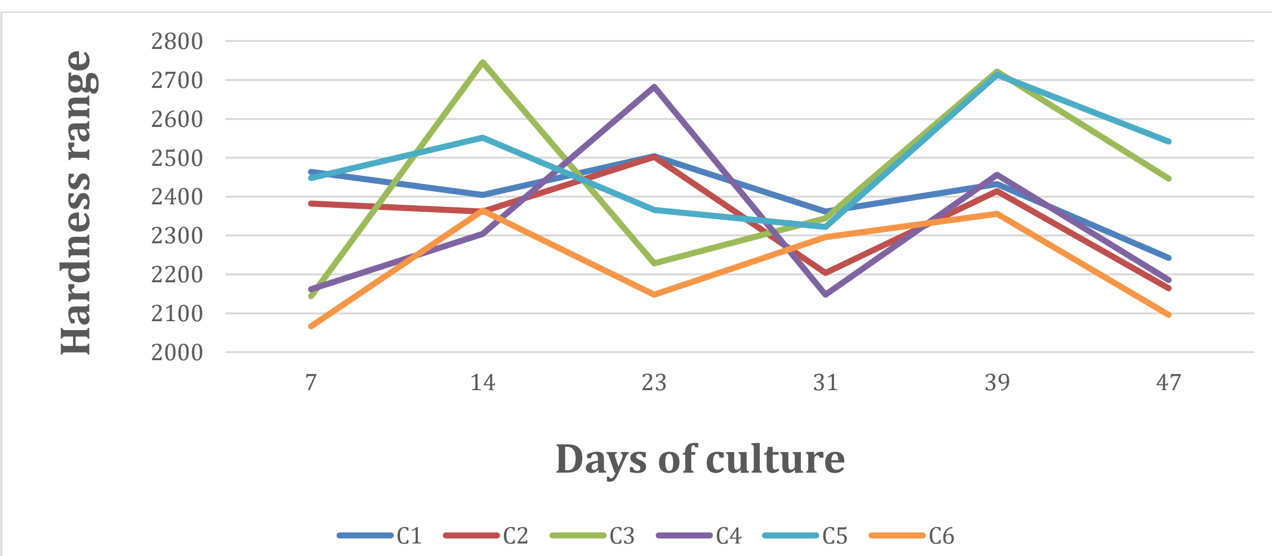

Figure 9:

Hardness of *P. vannamei* pond during the study period

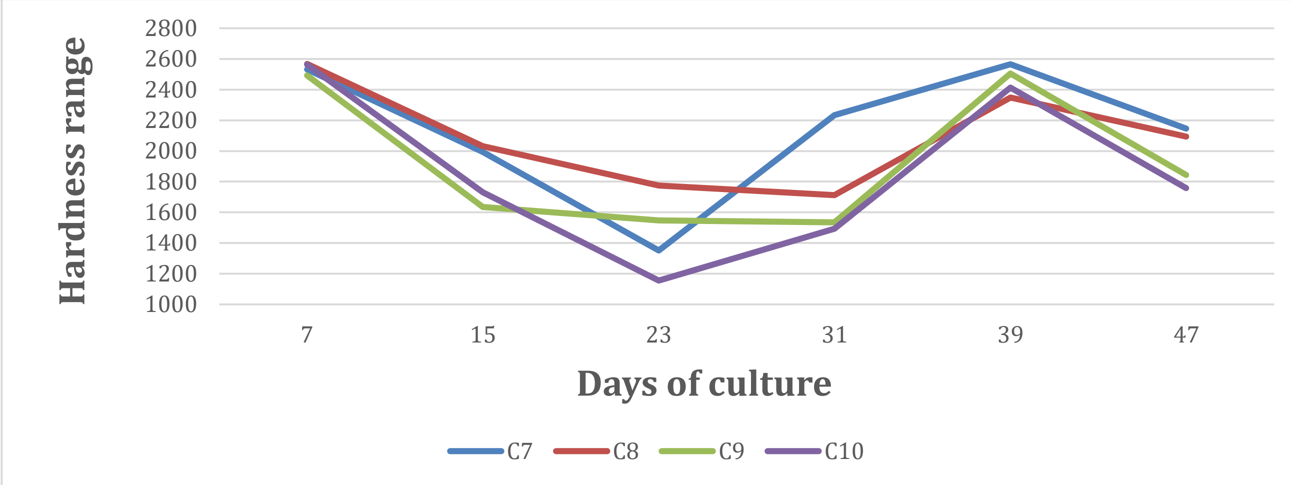

Figure 10: Hardness of *P. monodon* pond during the study period

Table 4: Survival, ABW and cumulative feed for *P. vannamei* during the culture period

Pond No.	Stocking density (lakhs)	Survival rate (%)	Average body weight (g)	Cumulative feed (kg)	Total biomass (kg)
C1	1.5	96	29.41	4616.5	4235.40
C2	1.5	97.2	27.77	4575	4048.86
C3	3.5	93.6	28.57	10576	9359.53
C4	3.5	95.4	30.30	11331	10117.17
C5	3.5	94.9	31.25	11625	10379.68
C6	3.5	97.4	31.25	12144.5	10653.12

Table 5: Survival, ABW and cumulative feed for *P. monodon* during the culture period

Pond No.	Stocking density (lakhs)	Survival rate (%)	Average body weight (g)	Cumulative feed (kg)	Total biomass (kg)
C7	0.5	96	47.61	3154	2285.71
C8	0.5	92.5	50.0	3098	2312.52
C9	1.25	87.2	55.5	8115	6056.26
C10	1.25	92	58.82	8994	6762.66

Table 6: FCR of *P. vannamei* during the culture period

S. No.	Pond No.	Cumulative Feed (Kg)	Total Biomass(Kg)	FCR
1	C1	4616.5	4235.40	1:1.09
2	C2	4575	4048.86	1:1.13
3	C3	10576	9359.53	1:1.13
4	C4	11331	10117.17	1:1.12
5	C5	11625	10379.68	1:1.2
6	C6	12144.5	10653.12	1:1.4

Table 7: FCR of *P. monodon* during the culture period

S. No.	Pond No.	Cumulative Feed (Kg)	Total Biomass (Kg)	FCR
1	C7	3154	2285.71	1:1.38
2	C8	3098	2312.52	1:1.34
3	C9	8115	6056.26	1:1.34
4	C10	8994	6762.66	1:1.33

Diseases: Shrimps were infected by many disease causing pathogens such as virus, bacteria, fungi, protozoa etc. These are almost similar in the native tiger shrimp, *P. monodon* as well as non native exotic, white legged pacific shrimp, *P. vannamei*. The diseases were identified and treatment of both common and rare diseases was diagnosed (Noga, 2010; CIBA. 2015).

The observed diseases in the present culture pond:

1. White faces disease (WSF) and white gut:

White faces syndrome recently has been noted as serious problem *for P. vannamei.* Usually occur after 60days of culture and it may be accompanied by high shrimp mortality. Another important syndrome observed in *P. vannamei* farming is white gut. Though these are two different problems, they are causing a serious concern and generally attributed to the harmful blue green algae, gregarines, vibrio. High pH, high nitrite in pond water may also lead to white feces (Fig 11).

Figure 11: White Faces Disease

Symptoms:
Gut appears white in colour, Pond affected with white feces syndrome show white fecal strings floating on the pond surface, Reduced feed consumption, growth retardation and often death is observed.
Preventive measures:
Reduce the accumulation of organic load there by curtail the bacteria load and blue green algae, Select good quality seed and follow good management practices.

2. Black gill disease:

Accumulation of organic load, feed waste leads to the formation of toxic gases like ammonia, nitrite and hydrogen sulphide are the main causative factors for this disease. Sometimes vibrio and/or bacteria may also pose blackening gills in shrimp. Low D.O levels in pond waters associated with black gill cause death in pond (Fig 12).

Figure 12: Black gill Disease

Symptoms:

Gills become black in colour and shrimps swim on the surface of the pond, Death may be noticed at low D.O condition.

Preventive measures:

Follow good management practices**,** Usage of oxygen tablets and also continuous aeration**,** Usage of $KMnO_4$ (500gm / acre) to control the disease.

3. Enterocytozoon hepatopenaei (EHP):

EHP infects the tubules in the shrimp's hepatopancreas and damages the organ's ability to gain nutrition from feed. Total elimination of EHP may not be possible. The best approach is to lessen the amount of EHP coming into ponds and then to control its levels in the ponds. It is widely understood that EHP limits growth, but does not cause mortality (Fig 13).

Figure 13: Enterocytozoon hepatopenaei

Diagnosis:

The pathogen can be detected using gene-based tools such as polymerase chain reaction (PCR) and loop-mediated isothermal amplification (LAMP) testing of feces from broodstock. These methods can also be used with postlarvae. Light microscopy can be used, as well, although it can be very difficult to visualize the very small spores. Effective screening of broodstock requires examination of individual animals, a costly practice.

Treatment:

Microsporidian infections are typically treated with drugs, but those drugs are unlikely to be effective against EHP because they target specific tissues. Dealing with EHP requires a three-pronged strategy: hatchery biosecurity, pond preparation and pond management.

4. Bacterial vibriosis:

Two species of vibrio are found to be pathogenic to the shrimps. They are *Vibrio parahaemoliticus* and *Vibrio harveyi* (Fig 14). It easily affects shrimp cultured in saline waters and known as bacterial septicaemia. The shrimp are affected at any stage. Environmental stress aggravates the disease and cause huge losses to *vannamei* farmers.

Figure 14: Bacterial vibriosis

Symptoms:

The affected shrimps exhibit septecaemia conditions followed by loss of reflex and cuticular fouling, the gills appear brown in colour and the body becomes red, antennal cut is also been observed, the affected shrimps do not eat and hence their stomach appears empty and at times white watery liquid oozes out. Sometimes luminescence has also been observed in ponds; in serious condition mortality could be observed.

Prevention:

Drying of the pond after the production cycle, adopting strict biosecurity measures, good water quality management, bacterial free good quality seed selection, use of sanitizers are some of the precautionary measures we take against this bacterial attack, in hatcheries, larval and post larval tanks should be thoroughly washed and cleaned to remove biofilms.

Discussion:

The present study was based on the water quality parameters, survival rate, growth, feeding, diseases, FCR and biomass in the culture of *P. vannamei* and *P. monodon.* The quality of water in any culture system plays a critical role and shows an impact on growth and survival of the shrimps (Krishna et al., 2006). So good water quality is essential for shrimp culture and is characterized by DO, Salinity, pH, alkalinity and hardness. The quality of water in shrimp culture depends on the feed, fecal matter and the percentage of metabolic wastes released during the culture process (Soundarapandian and Gunalan, 2008). Low Salinity (up to 1 ppm) has no effect on growth, survival and feed conversion rate in *P. vannamei* (Jaffer et al., 2020). All penaeid shrimps can grow in a wide range of salinities (Paulraj and Sanjeevaraj, 1982). In the present study, the survival rate of 97.2% was observed in *P. vannamei* with a salinity range of 7.3 to 9.6. The survival rate was 96% in *P. monodon* where the salinity was in the range of 8.2 to 9.5 which indicates that the species can tolerate wide range of salinity variations (Shailender et al., 2012). According to Balakrishnan et al., (2011), the percentage survival of 80-92% was observed in *P. vannamei* culture at a pH range of 7.9 -9.1. According to Praveen kumar and Krishna (2015), the survival (%) and AVG was observed as 84.5; 83.5; 82.5; 79.5; 69.12 and 28.42g, 27.52g, 26.4g, 25.2g and 19.5g in *L. vannamei* from semi-intensive culture ponds from Nellore district. The total biomass of *P. vannamei* during the culture period was 48,792.9 kg and for *P. monodon* was 17,418.15 kg. The productions were observed as 3541.2kg, 4205.4kg, 5192.6kg, 5962.2kg and 5046.6kg and the percentage survival was 80.4, 79.6, 78.4, 78.2 and 73.4 with respect to the densities of 40/m2, 50/m2, 60/m2, 70/m2 and 80/m2 of Pacific White Shrimp *Litopenaeus vannamei* at different stocking densities under semi intensive culture systems in Andhra Pradesh (Krishna, 2006). The culture of white leg shrimp (*L. vannamei*) and black tiger shrimps (*P. monodon*) are both profitable and the white leg shrimp culture is more economically profitable with higher productions mainly due to its early maturation (Ubair Nisar et al., 2021). Shrimps are able to tolerate acidity between 4.0-11.0 (Chamberlain, 1988) and pH levels 7.5-8.2 (Effendi et al., 2016). In the present study the pH varied from 7.77 to 8.2 in *P. vannamei* and from 7.99 to 8.5 in *P. monodon.* In the present study the DO is greater than 4 mg/L which was quiet suitable for the shrimps (Boyd, 1990). Seven major diseases viz. White Spot Syndrome Virus (WSSV), Black Gill Disease (BGD), Running Mortality Syndrome (RMS), Loose Shell Syndrome (LSS), White Fecal Syndrome (WFS), White Muscle Disease (WMD) and Infectious Hypodermal and Haematopoietic Necrosis (IHHN) were found in *L. vannamei* culture ponds of all the three divisions of the Visakhapatnam district (Srinivasa Rao et al., 2021). The diseases are serious problems posing threat to sustainability of *L. vannamei* culture. The SPF status does not ensure that it is free from all the diseases.

Therefore, the threat of shrimp diseases continued to remain. The practice of bio-security measures like bird fencing, crab fencing, filtration and disinfection of water before pumping into the main pond helped to contain the spread of the disease particularly the carriers of the pathogens. The implementation of Better Management Practices (BMP) at every stage also helped to contain the spread of the disease (Shailender et al., 2012; Srinivasa Rao et al., 2021, Ubair Nisar et al., 2021, Jagadeesh et al., 2022, Kuldeep, 2022, Khushbu 2022, Akshay and Malay, 2024). The major constraint mitigating shrimp farming was the disease problem that can be mitigated by optimum stocking densities and proper feed management. From the present study it was concluded that *P. vannamei* and *P. monodon* culture was successful in brackish water environment and growth was related to stocking density, supplementary feeds and water quality parameters. Maintenance of good water quality parameters can reduce the risk of diseases in these shrimp cultures and also these are able to tolerate wide range of water quality parameters making them a target species for aquaculture.

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