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The effect of ionic concentration of low saline waters on growth characteristics of *Penaeus vannamei*

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Abstract
Inland shrimp culture is being practiced in several regions of India. The culture of Pacific white shrimp (*Penaeus vannamei*) in low saline inland waters faces several challenges. The ionic composition of these waters is generally deficient in several key minerals, including potassium (K+) and magnesium (Mg2+). Thus the study was carried out in three grow out ponds namely P1, P2 and P3 having different salinity as well as different ratio of calcium and magnesium to evaluate the growth performance of *P. vannamei* in low saline waters. It was observed that survival and growth rate of *P. vannamei* is in the order of P1>P3>P2. This study reveals that Mg:Ca concentration need to be maintained at 3: 1 ratio for the better survival, growth rate and production

Keywords: *P. vannamei*, Low saline, magnesium, growth rate, survival

1. Introduction
The culture of shrimp utilizing low salinity water (LSW) has become common practice in a number of countries worldwide. The Pacific white shrimp, *Penaeus vannamei*, is the preferred shrimp species for culture in LSW, primarily due to its remarkable ability to effectively grow and survive at extreme salinities(0.5– 40 ppt) [1-3]. The inland waters available for shrimp culture are usually of different salinities and possess different ionic compositions based on their source [4]. Though some farmers have relatively got success in culturing *P. vannamei* in inland low salinity waters, problems still arise from deficiencies in the ionic profiles of pond waters [5-6]. The lack of a necessary mix of essential ions, including potassium (K^+) and magnesium (Mg^{2+}), has been demonstrated to limit growth and survival of shrimp [5,7]. Both K^+ and Mg^{2+} are ions essential for normal growth, survival, and osmoregulatory function of crustaceans [8-9]. Magnesium also plays a role in the normal metabolism of lipids, proteins, and carbohydrates serving as a cofactor in a large number of enzymatic and metabolic reactions [10]. In general, two separate strategies have been employed by researchers to improve growth and survival of *P. vannamei* reared in LSW. These strategies include water modification approaches which alter the low salinity rearing medium to make it more acceptable for production of shrimp and nutritional strategies that focus on modification of diets offered to shrimp, usually with supplements that might theoretically improve osmoregulatory capacity. Thus the objective of the present study was carried out to study the growth characteristics of *P. vannamei* in low saline waters and to optimize the calcium and magnesium requirement in low saline waters

2. Materials and Methods
The present study was conducted in low saline waters of three culture ponds over a period of 90 days. Among three ponds one is located near creek having salinity of 9.0 (P1) which served as control pond and the other two ponds are with inland saline waters having 2.4 and 1.4ppt (P2 & P3) respectively. The ponds were stocked with PL 10 at rate of 80 nos. per m^2. The post larvae were acclimatized to respective low salinity before stocking. Initially, the inland low pond waters were treated with Lime stone and Magnesium Sulphate / Magnesium chloride, to increase the concentration of Mg and Ca in waters at 1:1.5, 1:2 ratio in P2 and P3 respectively. The P2 and P3 ponds were treated with murate of Potash to increase K on par with K concentration in diluted seawater of particular salinity. Once in ten days, Magnesium sulphate was added as a boosting dose to compensate the loss via seepage,

sediment sink, uptake by animals. Each ponds were equipped with paddle wheel aerators. Weekly sampling was carried out. The physicochemical parameters of water such as pH, alkalinity, hardness, Ammonia, Calcium and Magnesium [11] and growth parameters of *P. vannamei* such as length, weight, growth rate, survival and production were studied.

3. Results and Discussion

The salinity of the experimental pond waters varies from 8.4-8.8, 2.2-2.4, 1. 2-1.4 during the culture period in P1, P2 and P3 respectively. The Hardness level also varies from 930-1110, 830-960 and 900-1020 respectively in P1, P2 and P3. The pH value varies from 7.4 to 8.5 in all three ponds. The Alkalinity level varies from 90-130, 190-220 and 90-220 in P1, P2 and P3 respectively. This range is within the stipulated range for aquaculture i.e between 60-300mg/l. The Dissolved oxygen level was maintained above 3mg/l throughout the culture period. The Ammonia level was maintained less than 0.1mg/l throughout the culture period.

The Comparison of hardness, Calcium, Magnesium and Ammonia in three ponds (P1, P2 and P3) is given in Fig. 1, 2 and 3. The hardness level in the control pond was found to be 1720-1760mg/l. where as in P2 and P2 the level fluctuates widely from 720-1020 and 760-1400 respectively. Though minerals were applied to raise the hardness, it is not uniformly maintained. This is mainly because of the absorbance of minerals in the soil surface and release back to water. During culture period, the Calcium and Magnesium level in P2 and P3 ponds were maintained at 1:1.5 and 1:2 level by weekly addition of Magnesium sulphate in order to compare the Growth and survival of P2 and P3 with P1. The growth rate of *P. vannamei* in P1, P2 and P3 is given in Fig.4.

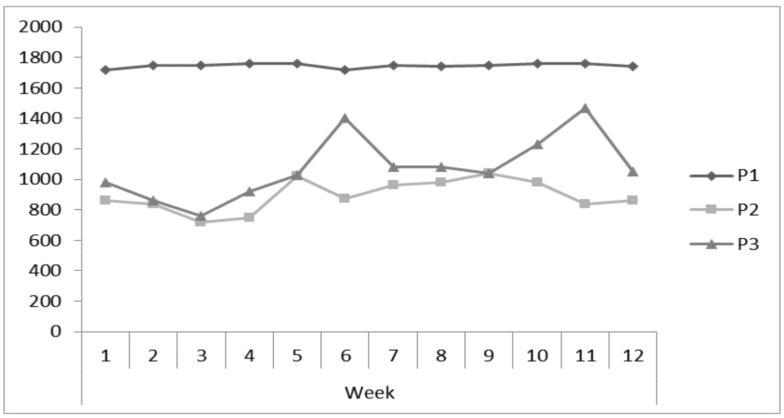

Fig. 1: Comparison of Hardness in three ponds (P1, P2 and P3)

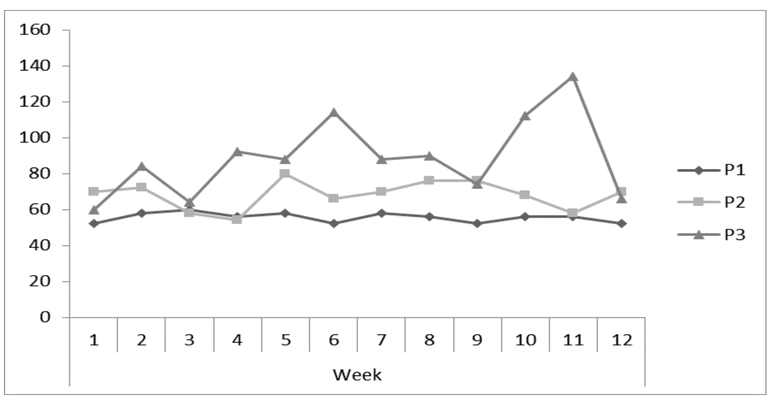

Fig 2: Comparison of Calcium in three ponds (P1, P2 and P3)

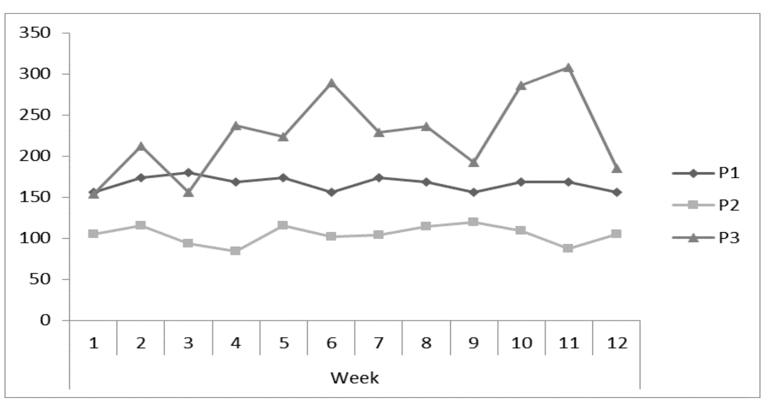

Fig. 3: Comparison of Magnesium in three ponds (P1, P2 and P3)

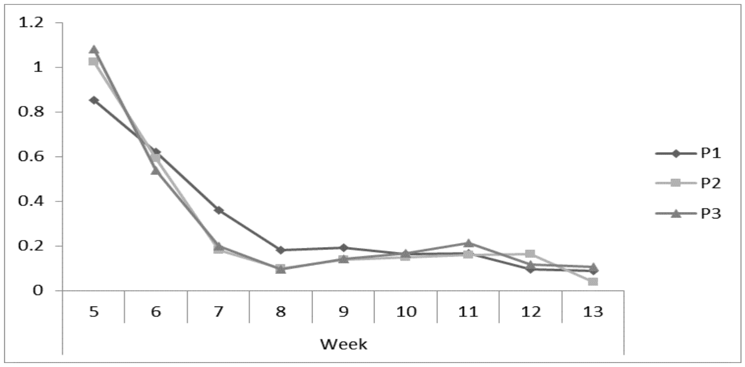

Fig 4: Comparison of Growth rate in three ponds (P1, P2 and P3)

The study reveals that survival rate is higher in P1 (88%) followed by P3 (85%) and P2 (83%). As P1 is a brackish water pond, the survival rate is higher than the other two ponds. The lower survival rate is due to low magnesium concentration than those of normal seawater diluted to the same salinity. Sowers *et al*., 2005; Roy *et al*., 2007 demonstrated [12-13] that Magnesium application increases the survival rate of Post larvae.

The production and the growth rate was also in the order of P1 > P3 > P2 (4.4t>3.23t>3.4t). This may be compared with Magnesium: Calcium (Mg: Ca) ratio. In a P1 pond Mg: Ca ratio is naturally 3: 1. Whereas in P2 and P3, it is 1: 1.5 and 1:2. Survival and growth of shrimp in inland low salinity well water of Alabama is affected mainly by the potassium concentration in the water and to a lesser degree by magnesium concentration [5, 14]. Boyd and Thunjai, (2003) [4] suggested that until data on ionic requirements of water for inland shrimp culture are developed through laboratory studies, the concentrations of calcium, magnesium, potassium, and sodium should be maintained similar to those of normal seawater diluted to the same salinity. Roy and Davis (2010) [15] suggested that ratios of Mg:Ca should also approximate those found in natural seawater (3.1:1) to ensure adequate survival of *P. vannamei* reared under low salinity conditions. Davis *et al*., 2004 reported that it would be ideal if Mg levels could be raised to 100% of what the Mg levels are at a given salinity.

4. Conclusion

Thus present study reveals that though *P. vannamei* could be cultured in low saline waters having low Mg:Ca ratio (<3:1), the survival and production is poor compared to the one which is cultured in 3:1 ratio. The research in mineral requirements is highly in need to find effective concentration of Mg:Ca ratio or optimum concentration of Magnesium requirement for the better utilization of inland low saline waters and enhancement of *P. vannamei* production.

5. Acknowledgement

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6. References

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