EPRA International Journal of Agriculture and Rural Economic Research (ARER)- Peer-Reviewed Journal
Volume: 12 | Issue: 12 | December 2024 | Journal DOI: 10.36713/epra0813| Impact Factor SJIF(2024): 8.391| ISSN: 2321 - 7847

AQUATIC ENVIRONMENT HEALTH OF EARTHEN PONDS AND CONDITION INDEX OF WHITELEG SHRIMP (*Litopenaeus vannamei* Boon, 1931)

N.C.Ujjania, Bengani. R*, Yamini Tandel
Department of Aquatic Biology
Veer Narmad South Gujarat University, Surat (Gujarat)

Article DOI: https://doi.org/10.36713/epra19335
DOI No: 10.36713/epra19335

ABSTRACT----------
The study on the Aquatic Environment Health of Ponds and Condition Index are important factors for evaluating the physiological status of the shrimp. The morphometric measurements studied were the total length and weight of 1200 randomly selected shrimp specimens from four different earthen ponds located at Palsana, Valsad (Gujarat) during the culture period. Based on the findings of this research, it is concluded that the water quality parameters such as temperature, pH, salinity, dissolved oxygen, alkalinity, and hardness were optimum which indicated the suitable environmental conditions for shrimp growth. The observed length, weight, and condition factor (K) of shrimp in all the studied ponds (A, B, C and D) were significantly different. The Correlation coefficient (r) between the variables Condition factor and AEHP showed salinity as an important regulatory factor. The findings showed that the farm operation would be helpful for the farmers to proceed with the economic shrimp production. The findings suggest that the ecological indices (AEHP and Condition Index) in cultured shrimps provide useful information about cultural conditions to the farmers and aquaculture experts. The farm operators could use these indices to assess individual health and habitat conditions through the application of appropriate farming operations.

KEYWORDS: *Length, weight, condition, culture, earthen pond----------*

INTRODUCTION

Shrimp aquaculture is expanding at a very rapid pace globally. Among penaeid shrimps, the Pacific white shrimp, *Litopenaeus vannamei* (Boone, 1931), is the most important species farmed worldwide (Alcivar-Warren et al. 2007). *L. vannamei*, owing to its high growth rate, euryhaline nature, and year-round availability of healthy post-larvae (PL), is the preferred crustacean species for coastal aquaculture. *L. vannamei* could potentially compete with native shrimp species because it approaches food items faster and is more aggressive than native shrimp (Chavanich et al., 2008; Panutrakul et al., 2010). The success *of L. vannamei* in farming systems is due to the ability to tolerate wide salinity ranges (0-45 ppt), fast growth rate, low dietary protein requirement (30-35%), column feeding habit and amenability for crowding and very high stocking densities(Ravichandran et al.,2009). The global culture production of *L. vannamei* in 2010 was 2.6 million tons, accounting for 71.8% of the world production of all farmed marine shrimp species and 77.8% of which was produced in Asia (FAO, 2012).

India is one of the top producers of farmed shrimp. *L. vannamei* was introduced to Asia for the first time in China in the year 1996 and thereafter farming commenced on a commercial scale. In India, during the last decade, a vast expanse of coastal land has been devoted to farming L. vannamei which is gradually replacing Penaeus monodon culture. *L. vannamei* is generally cultured in coastal ponds constructed in estuarine zones and the construction of ponds causes large-scale destruction of ecologically important mangrove populations (Primavera, 1994). Intensive shrimp culture practices necessitate the use of supplementary feed, fertilizers as well as antibiotics and chemotherapeutics which are ultimately discharged into the surrounding environment, leading to harmful impacts. Coastal areas or estuaries are characterized by weak currents and less water renewal, resulting in shrimps cultured in coastal ponds being exposed to pollutants because of less water dispersal ultimately leading to disease outbreaks and mass mortality.

Shrimps are valued seafood harvested from coastal tropical and warm-temperature waters throughout the world. Shrimps support commercially valuable fisheries in many areas of the world (Ajani et al.,2013). In recent decades, because of the high demand for shrimps, shrimp aquaculture has expanded rapidly all around the world (Lombardi et al.,2006). After the worldwide spreading of spot and other viral diseases, disaster mortality and severe damages

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and economic losses occurred in shrimp culture systems, particularly in Asia. It is now evident that *L. vannamei* is farmed and established in several countries in East, Southeast, and South Asia and is playing a major role in shrimp aquaculture production Balakrishnan et al,2011).

Length-weight relationship and condition factor are extremely useful tools for understanding the biological changes in aquatic organisms (Shah et al.,2013). Furthermore, standing crop biomass can be estimated (Morey et al., 2003) and seasonal variations in aquatic growth can be tracked in this way. The length-weight relationship also helps in predicting the condition, reproductive history, and life history of aquatic species (Nikolsky,1963) and in morphological comparison of species and populations (King,1996). The condition factor is often associated with fitness, that is, a poor condition can manifest several negative fitness consequences for the individual and fish populations. The somatic growth potential of aquatics can be reduced. Reproductive success can be reduced through some factors like lower fecundity, and poor quality eggs and sperm. Additionally, poor conditions may also lower the chances of survival. The study was carried out to find out the environmental as well as biological health of the cultured earthen pond for the sustainable production of shrimps.

MATERIALS AND METHODS

Experimental Details

The present study was undertaken in earthen ponds at Dhanlaxmi Aqua Farm, Palsana, Gujarat for the period of 120 days from the stocking which were constructed in a parallel manner (Table. 1)

Pond Preparation

The pond preparation was done with standard procedures applied for a semi-intensive farming system including repairing, pond construction, drying and liming, fertilizing, application of probiotics, etc.

DATA COLLECTION

For monitoring AEHP, water samples were collected from all four studied ponds. The water quality parameters like temperature, salinity, pH, dissolved oxygen, alkalinity, and total hardness were measured using a refractometer, pH test kit, dissolved oxygen test kit (Aquasol, Rakiro Biotech Sys Pvt. Ltd.), Alkalinity test kit (Biosol, A.A. Biotech Pvt. Ltd.) and Total Hardness test kit (Aquasol, Rakiro Biotech Sys Pvt. Ltd.) respectively. The morphometric measurements (total length and weight) of 1200 specimens (300 from each pond) were randomly collected from January to March 2020. From each specimen, the total length was measured from the tip of the rostrum to the end of the telson at the nearest 0.1 cm with the help of a measuring board while the weight of wiped shrimp was measured by electronic single pan balance at the nearest 1.0 gm.

Data analysis

The condition factor (K) is considered as the percentage of bodyweight with a cube of the total length and was calculated following equation $K=W/L^3\times100$ (Htun-Han,1978) where 'W' is the weight (gm) of shrimp, 'L' is the total length (cm) of shrimp, 'a' is the intercept of variables and 'b' is the slope of variables. The graphical presentation and interpretation of data was carried out using 'MS Excel 2019.

RESULT AND DISCUSSION

Aquatic Environment Health Parameters (AEHP)

The mean temperature of earthen ponds during the study was observed (28.93 ± 0.55), 29.29 ± 0.59, 29.14 ± 0.60 and 29.29 ± 0.46) ^{0}C from pond A, B, C and D respectively (Fig. 1). The mean pH of earthen ponds during the study was observed 8.29 ± 0.07, 8.39 ± 0.06, 8.39 ± 0.06, 8.34 ± 0.08 in pond A, B, C and D respectively (Fig. 2). The average salinity of earthen ponds during the study was observed 22.58 ± 2.70, 25.58 ± 3.22, 25.86 ±3.32,30.86 ± 2.39 in pond A, B, C and D respectively (Fig. 3). The average value of Dissolved Oxygen of earthen ponds during the study was observed 5.93 ± 0.25, 6.07 ± 0.20, 6.07 ± 0.23, 6.07 ± 0.25 from ponds A, B, C and D respectively (Fig. 4). In the present study the mean total alkalinity of earthen ponds recorded was 210.00 ± 4.88, 215.71 ± 8.95, 210.00 ± 7.56,08.57 ± 4.59 from pond A, B, C, and D respectively (Fig. 5). During the study the mean hardness of earthen ponds was found 4371.43 ± 478.64, 5161.43 ± 612.30, 4887.14 ± 525.82, 6140.00 ± 452.04 in A, B, C, and D respectively (Fig. 6).

The water quality parameters play an important role in the culture system. Water quality management is essential for optimum growth and survival of shrimp. Excess feed, faecal matter and metabolites will exert tremendous influence on the water quality of shrimp farms (Soundarapandian and Gunalan, 2008). Mascareno and Jimenez (2013) recovered the satisfactory growth of L. vannamei with water temperature 22.5 to 28.3°C, salinity 35 to 36 ppt, pH 8.2 to 8.5, and DO concentration 4.8 - 7.1 mg/l.MPEDA (2017) suggested that the water quality parameters under best management practices for white leg shrimp that water temperature should be within 28 - 32°C. Hardness (3020 - 7940 mg/l) was found to increase with the increase of days of culture period due to tidal action.

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The optimum production of shrimp was found at 25 - 30℃ temperature, which was similar to the present study (temperature 26.5 - 31.5℃) and pH ranged from 8.0 - 8.6 during the study period, which was similar to the recommended level of pH 8.0 - 8.5 for shrimp farming (Mazid, 2009). A salinity range of 10 - 35 ppt is ideal for shrimp culture (Gunalan et al., 2011). Dissolved oxygen levels were maintained within the range in all four ponds during the study period because of the use of aerators. Chin and Ong (1994) pointed out that a DO concentration of 3.8 to >5.0 mg/l is generally found favorable for shrimp culture, which supports the present findings (5.0-7.0 mg/l). Islam et al. (1998) reported the ranges of DO in the Mongla and Paikgacha area of Bagerhat and Khulna district was 5.1-8.7 and 5.7-8.1 mg/l, respectively. Dissolved oxygen measured from the present study is therefore suitable for shrimp culture. The natural fertility of pond water increases in total alkalinity up to at least 150 mg/l (Boyd, 1998). Ahmed et al. (1997) found the range of alkalinity in semi-intensive farms of Cox's Bazar district was 44.0-195 mg/l and Islam et al. (1998) also found 130.0-217.5 and 118.0-187.5 mg/l total alkalinity in Mongla and Paikgacha area of Bagerhat and Khulna district, respectively. This is more or less similar to the present findings (180 - 240 mg/l). Larkins (1995) also suggested that the alkalinity range from 60-140 mg/l is suitable for shrimp culture. The research findings were higher than the recommended level of alkalinity of shrimp farming which is due to excess amount of agricultural lime and fertilizer in shrimp farms. The optimum range of hardness for shrimp farming ranges from 2325 to 2715 mg/l (Mazid, 2009). During the study period, the values of hardness were recorded ranging from 3020 - 7940 mg/l. The present estimation shows that the increase of total hardness with an increase in culture period. The higher level of hardness values in shrimp farming may be due to the higher salinity. The variation of photosynthetic activities of phytoplankton, which utilize free carbon dioxide and increase the calcium carbonate level (Singh. 1994). Clark (1954) found more carbonate when free carbon dioxide was taken up from water by photosynthesis.

Length and Weight Measurement

In the present study minimum, maximum and mean lengths of the shrimp measured were 9.500 cm - 17.800 cm (13.988 ± 0.097 cm) in pond A, 9.400 cm - 18.300 cm (13.940 ± 0.098 28 cm) from pond B, 8.700 cm - 17.800 cm (13.801 ± 0.108 cm) from pond C and, 8.700 cm - 17.400 cm (13.455 ± 0.091 cm) from pond D respectively, Table 1. Similarly the minimum, maximum and mean weight of the shrimp measured were 7.00-47.00 (23.24 ± 0.49 gm) from pond A, 6.00-48.00 (21.07 ±0.47 gm) from Pond B, 7.00-47.00 (21.44±0.51gm)from pond C and, 7.00-36.00 (19.08±0.38 gm) from pond D respectively, Table 1. Length and weight are the most common morphometric characteristics used to find out growth concerning environmental conditions, which is measured using the length-weight relationship (Okpala and Bono, 2015). Suriya et al. (2016) reported the harvest size of white leg shrimp 20.0-34.0 gm after 120 days of culture days in shrimp farms at Vellar estuary. Coddalore district, Tamil Nadu. This was similar to present findings the size of harvested shrimp was 8.7 - 18.3 cm in length and 6 - 48 gm after 120 days of culture. The wide range of size variation was observed; it might be due to stocking density, quality of seeds and intraspecific competition for resources which affect the growth of the shrimp. The results clearly depicted variation in the weight of shrimp in pond A and was dominant by 43 counts followed by pond C(46 counts), pond B(47 counts) and pond D(52 counts) respectively (Table 1).

Condition Factor(K)

The minimum value of K was recorded from pond B and C whereas the maximum was noted from pond C(Table 1, Fig. 7 and 8). These calculated values of K were close to one which indicated that the condition of the studied shrimp population was good and the aquatic environment of earthen ponds was conducive for the culture of shrimp. A similar finding was reported by Kunda et al.,2008 in *P.penicillatus* and Solanki et al.,2020 in *P. monodon* whereas, K values >1.0 was reported in *P.monodon* (Mane et al,2019; Mohanty et al,2015) and in *L. vannamei* (Okayi, and Iorkyaa,2004).

Correlation between AEHP and Condition Index

The correlation between AEHP and Condition Index is depicted in Table 2. The Correlation coefficient (r) between the variables Condition factor and AEHP showed salinity as an important regulatory factor. The correlation between AEHP and Condition Index is depicted in Table 2

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Table 1: Details of culture earthen pond and morphological parameter of shrimp

Parameter	Unit	Pond A	Pond B	Pond C	Pond D
		Min. – Max. (Mean ± SE)	Min. – Max. (Mean ± SE)	Min. – Max. (Mean ± SE)	Min. – Max. (Mean ± SE)
Pond area	Ha.	0.5	0.5	0.6	0.6
Days of culture	No.	120	120	120	120
Length	cm	9.50-17.80 (13.99 ± 0.10)	9.40-18.30 (13.94 ± 0.10)	8.70-17.80 (13.60±0.11)	8.70-17.40 (13.46 ± 0.09)
Weight	gm	7.00-47.00 (23.24 ± 0.49)	6.00-48.00 (21.07 ±0.47)	7.00-47.00 (21.44±0.51)	7.00-36.00 (19.08±0.38)
Condition Factor	K	0.59 - 1.04 0.81 ± 0.00	0.44 - 1.14 0.74 ± 0.01	0.44 - 1.32 0.82 ± 0.01	0.46 - 1.23 0.76 ± 0.01

Table 2: Correlation Coefficient (r) of the Variables (Condition factor and AEHP)

Condition Factor v/s Parameters	Pond A	Pond B	Pond C	Pond D
Temperature (^{O}C)	0.297	0.681	-0.857	-0.672
pH	-0.382	-0.013	0.418	0.402
Salinity (ppt)	0.530	0.676	-0.423	-0.509
Dissolved Oxygen (mg/L)	-0.412	-0.528	0.036	0.599
Total Alkalinity (mg/L)	0.282	-0.095	0.235	-0.314
Total Hardness (mg/l)	0.597	0.715	-0.335	-0.516

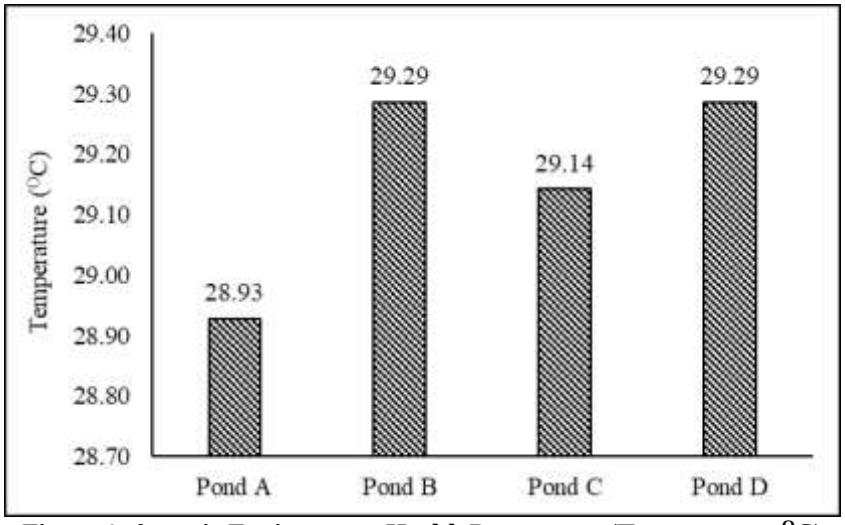


Figure 1. Aquatic Environment Health Parameters (Temperature, ^{O}C)

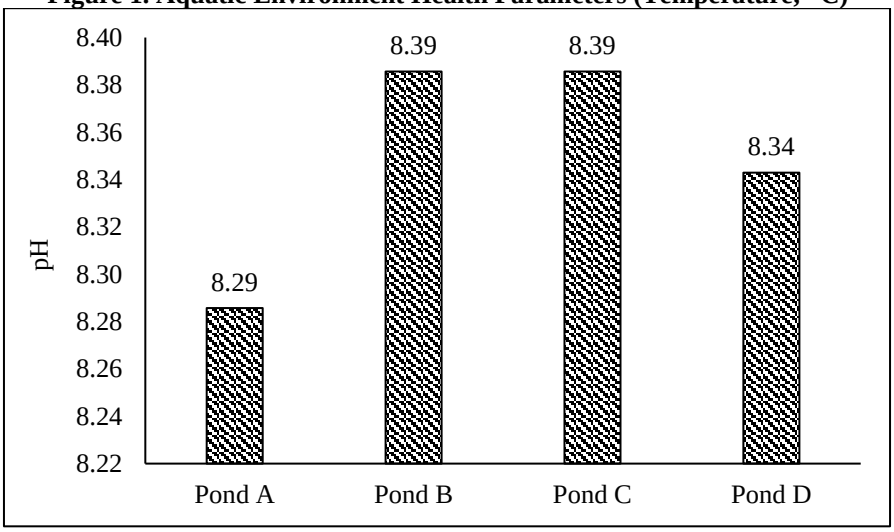


Figure 2. Aquatic Environment Health Parameter (pH)

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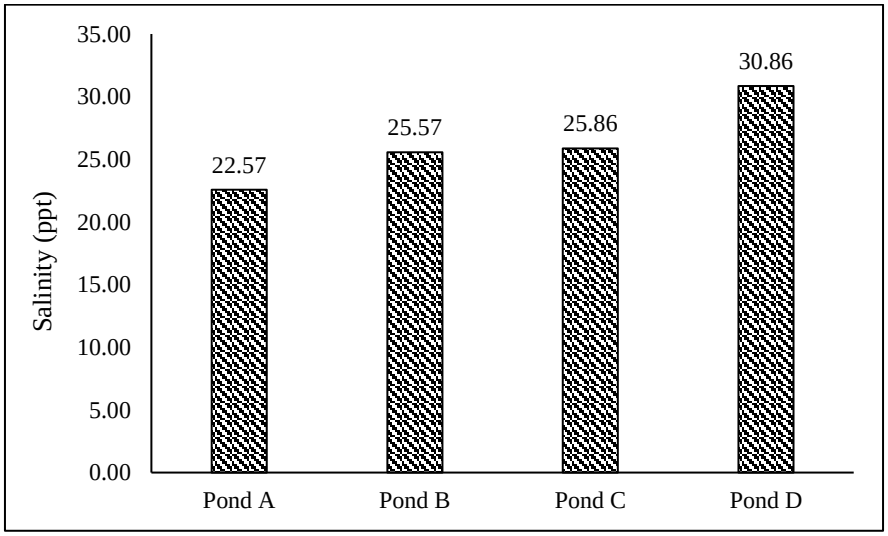


Figure 3. Aquatic Environment Health Parameter (Salinity, ppt)

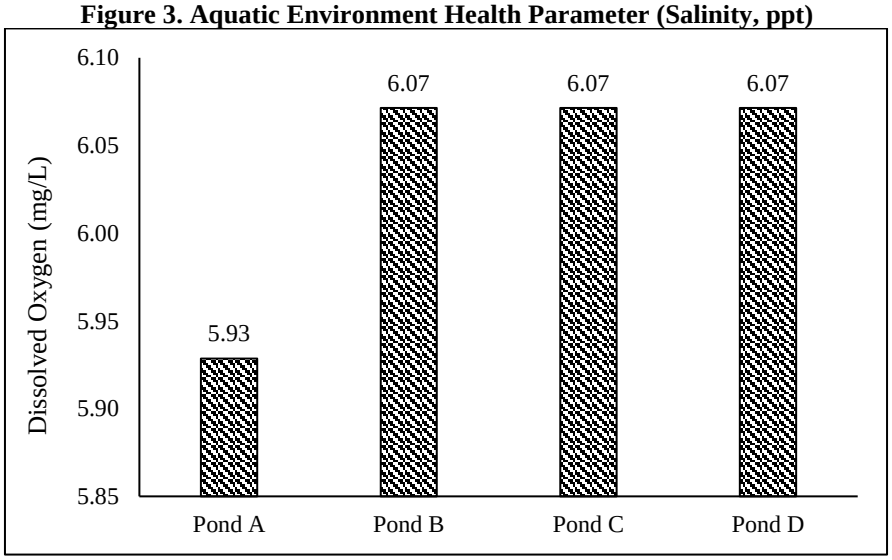


Figure 4. Aquatic Environment Health Parameter (Dissolve Oxygen, mg/L)

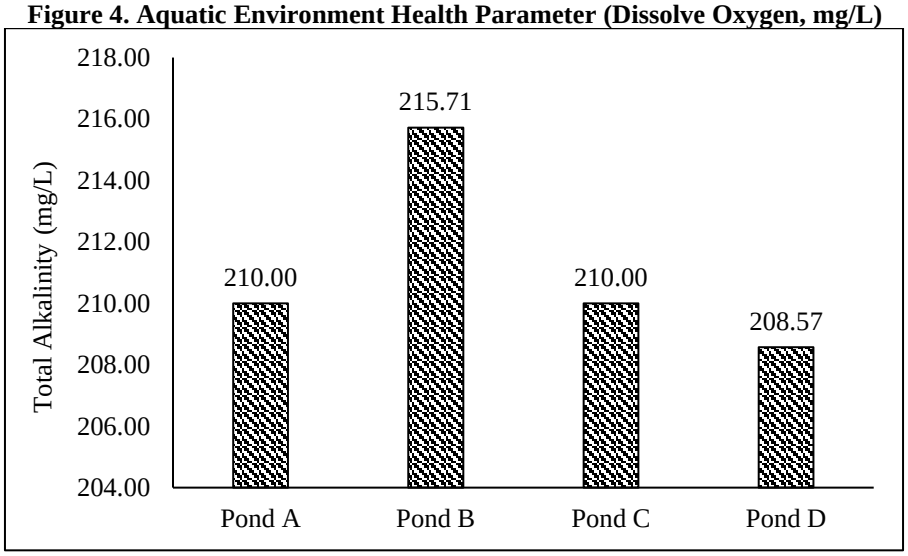


Figure 5. Aquatic Environment Health Parameter (Total Alkalinity, mg/L)

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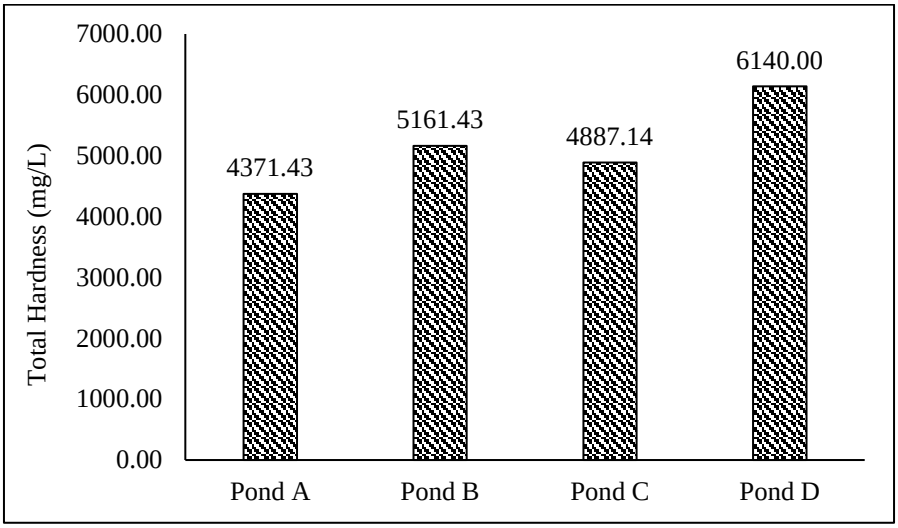


Figure 6. Aquatic Environment Health Parameter (Total Hardness, mg/L)

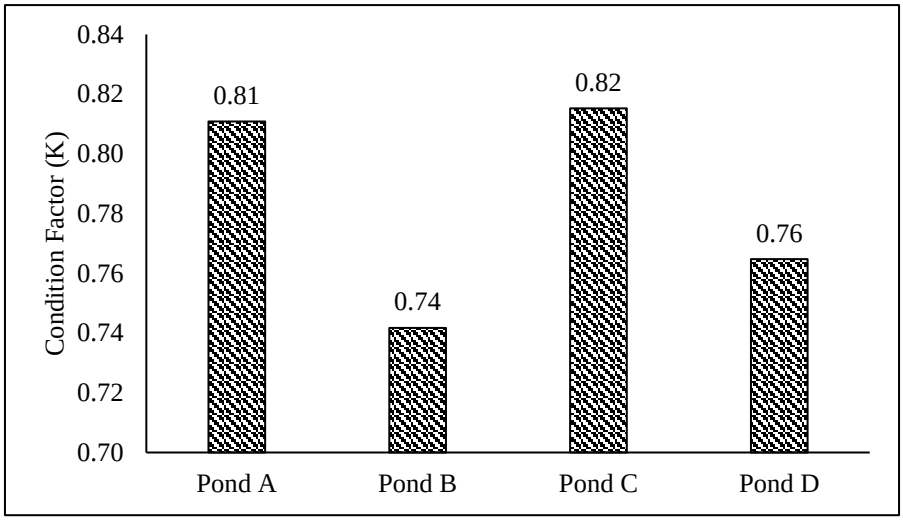


Figure 7. Condition Factor (K) of shrimp in Different Earthen Ponds

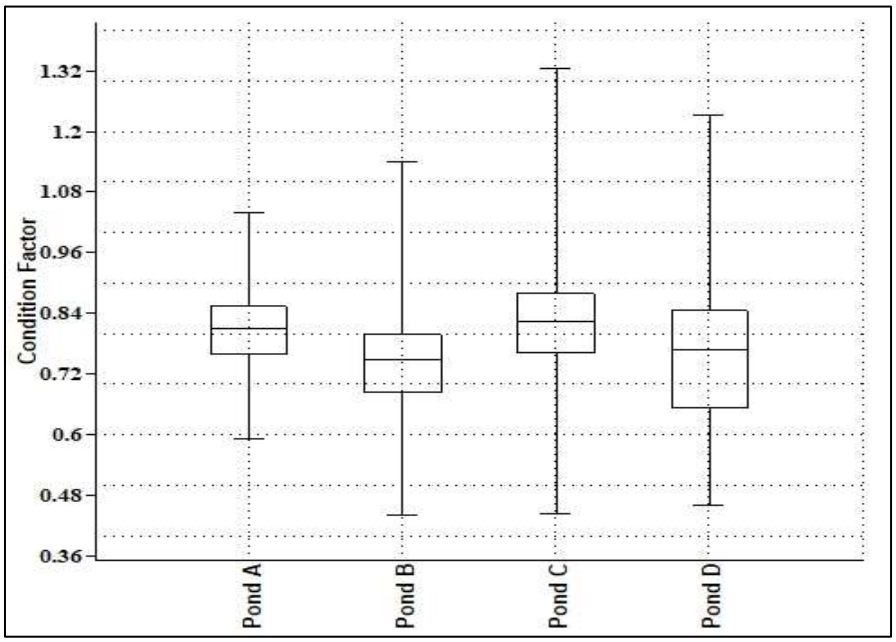


Figure 8. Box Plot of the condition factor of shrimp in different earthen ponds

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