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Research Article

Comparative Study on Growth and Condition Factor of Whiteleg Shrimp (*Litopenaeus vannamei* Boone, 1931) Cultured in Different Earthen Ponds

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Abstract

The study was undertaken to compare the growth and condition of a shrimp (*Litopenaeus vannamei)* on the basis of morphometric analysis based on length weight relationship and condition factor. The morphometric measurements included 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 cycle of 2020. The length, weight and condition factor were noted 9.500–17.800 (13.988±0.097) cm, 7.000–47.000 (23.237±0.494) g and 0.591–1.037 (0.811±0.005) in pond A, 9.400–18.300 (13.940±0.098) cm, 6.000–48.000 (21.070±0.469) g and 0.439–1.139 (0.742±0.006) in pond B, 8.700–17.800 (13.601±0.108) cm, 7.000–47.000 (21.440±0.512) g and 0.444–1.324 (0.815±0.007) in pond C and 8.700–17.400 (13.455±0.091) cm, 7.000–36.000 (19.077±0.376) g and 0.459–1.231 (0.765±0.008) in pond D respectively. The observed length, weight and condition factor (K) of shrimp in these earthen ponds (A, B, C and D) were significantly different. The correlation coefficient (r^2) observed was 0.940, 0.877, 0.836, 0.769 in pond A, B, C and D respectively that depicted strong linear relationship of the variables (length and weight of shrimp). The regression coefficient or growth constant (b) was noted 3.094 (isometric) in pond A, 3.143 (positive allometric) in pond B, 2.774 (negative allometric) and 2.588 (negative allometric) in pond D. Based on the weight of the shrimp, it was assessed that the studied shrimp were slightly heavy and counted 43 counts in pond A while 52 counts in pond D. The statistical analysis showed that the length, weight and condition factor (K) of the shrimp were significantly different among the shrimp population of the culture ponds. The findings showed that the application of uniform farm operation would be helpful for the farmers to proceed for the economic shrimp production through the application of appropriate farming operations.

Keywords: Pacific shrimp, LWR, condition, growth, earthen pond

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Introduction

Shrimp culture prolonged quickly around the world because of the high demand for seafood [1] and commercially valuable fisheries [2]. In aquaculture, farmers generally use growth in terms of weight to evaluate the profit, while aquatic scientists usually adopt the length and weight to assess fish growth in the field therefore regular monitoring of length and weight can help enhance production and the economics of aquaculture. The length-weight relationship resulted in the conversion of growth in length to growth in-weight in standard valuation models, as well as helped estimate the population biomass of the population.

The studied length and weight data were used to assess the growth rates, age structure of crustaceans [3, 4] and other aspects including biomass estimation [5], changes in aquatics [6], fisheries assessment [7] and growth assessment [8, 9]. It is also helpful for important aquacultural aspects like prediction of life history [10] and morphological comparison in populations of aquatic organisms [11, 12]. According to study of Silva et al., 2015, it is an important aquaculture management tool [13].

Therefore, these determinations are considered a convenient tool to compute the variation in the growth of aquatic organisms in natural and cultural environments [14] that would be important for aquaculture management [13] but diverge among the species, sexes, sampling sites and season [3]. Length-weight relationships for commercially important penaeid shrimp from Pichavaram mangroves, India [15], Gulf of California [16] and North Sumatra, Indonesia [17] were studied and they suggested that these parameters are suitable for studying the growth and wellbeing of the shrimp. Different research was undertaken to study the length-weight of shrimp (*Litopenaeus vannamei*) from East coast and West coast of India, respectively [18, 19]. Physical and biological circumstances are fluctuated by the interactions of feeding, infections and physiological factors which are reflected by the condition factors [20]. Condition factor is associated with the fitness, growth and condition of aquatic organisms [18, 21] and index of wellbeing and energetic condition of the species [22].

The condition factor (K) has also been used to assess the overall biotic and abiotic conditions for shrimp growth [15]. Different researchers from various farms and ponds studied the condition factors of shrimp cultured in different environmental conditions [22-27].

In cultured farms, condition factors and length-weight relationships are used to assess the health and habitat, such as food accessibility [7, 28] that are totally dependent on farm operations.

In this study, the important biological aspects (LWR and condition factor) were evaluated to justify the farm operations that resulted in the growth and condition of shrimp. Important information on the growth status and condition of the shrimp would be helpful to manage farm production and regulate the farming operations.

Materials and Methods

Culture of shrimp

The shrimps were reared in four different ponds (0.5-0.6 ha) namely A, B, C and D at Dhanlaxmi Aqua Farm, Palsana, Valsad District (Gujarat). The culture duration of shrimp was 120 days.

Data collection

The morphometric measurement (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 tip of rostrum to the end of telson at the nearest 0.1 cm with help of measuring board while weight of wiped shrimp was measured by electronic single pan balance at the nearest 1.0 g.

Data analysis

The LWR was estimated from total length (TL) and body weight (W) using equations $Y = a+bX$, $W = aL^b$ and $\log W = \log a + b \log L$ following standard protocols [20,29]. The condition factor (K) considered as the percentage of bodyweight with cube of the total length and was calculated following equation $K=W/L^3\times100$ [30] where 'W' is the weight (g) 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 statistical analysis of data was accomplished by using 'MS Excel 2019' and 'SPSS 16'.

Result and Discussion

In present study, the length of shrimp ranged from 9.500-17.800 (13.988±0.097) cm, 9.400-18.300 (13.940±0.098) cm, 8.700-17.800 (13.601±0.108) cm and 8.700-17.400 (13.455±0.091) cm, weight ranged from 7.000-47.000 (23.237±0.494) g, 6.000-48.000 (21.070±0.469) g, 7.000-47.000 (21.440±0.512) g and 7.000-36.000 (19.077±0.376) g whereas condition factor varied from 0.591-1.037 (0.811±0.005), 0.439-1.139 (0.742±0.006), 0.444-1.324 (0.815±0.007) and 0.459-1.231 (0.765±0.008) in pond A, B, C and D respectively (**Table 1**). The results clearly depicted variation in weight of shrimp in pond A and was dominant by 43 counts followed by pond C(46 count), pond B(47 counts) and pond D(52 counts) respectively (Table 1). The findings of the present study are in relation to the other research carried out in Shrimp [31, 32] whereas dominancy of younger and elder shrimp in the population was reported by the study of Fatima and Solanki et al., respectively [9, 33].

In length-weight relationship, the correlation coefficient (r^2) was noted 0.940, 0.877, 0.836 and 0.769 for the variables length and weight of shrimp in pond A, B, C and D, respectively that showed the positive and strong linear relations among the variables (Table 1 and **Figure 1**). The findings of Lalrinsanga et al. for freshwater prawn [22], Prajapati and Ujjania, for Whiteleg shrimp [32] and Das et al. for penaeid shrimp [34] are very close and supports the current results.

The growth constant called as regression coefficient (b) for the shrimp was observed 3.094, 3.143, 2.774 and 2.588 in pond A, B, C and D, respectively (Table 1). The observed values of the 'b' in present study was noted 3.0 in pond A that indicated the isometric growth and in pond B it was >3.0 which indicated positive allometric growth whereas the growth of the studied shrimp was negative allometric (b<3.0) in pond C and D which expressed that growth of shrimp was abnormal with respect to length. The growth constant (b) allows for conversion of growth-in-length to growth-in-weight in standard valuation models [13, 32] and in present study, negative allometric growth showed that the more growth-in-length while positive allometric growth showed the more growth-in-weight. Udoinyang et al. [35] and Das et al. [34] reported isometric growth in shrimp while Mane et al. [36] reported positive allometric growth. The similar finding on this aspect were also reported by different workers [7, 32].

Table 1 Length and weight of Whiteleg shrimp in different earthen ponds

Growth parameters	Ponds			
	Pond A	Pond B	Pond C	Pond D
Pond area (ha)	0.5	0.5	0.6	0.6
Days of culture (n)	120	120	120	120
Total length (cm)	9.500-17.800 (13.988±0.097)	9.400-18.300 (13.940±0.098)	8.700-17.800 (13.601±0.108)	8.700-17.400 (13.455±0.091)
Weight (g)	7.000-47.000 (23.237±0.494)	6.000-48.000 (21.070±0.469)	7.000-47.000 (21.440±0.512)	7.000-36.000 (19.077±0.376)
Condition factor (K)	0.591-1.037 (0.811±0.005)	0.439-1.139 (0.742±0.006)	0.444-1.324 (0.815±0.007)	0.459-1.231 (0.765±0.008)
Growth coefficient (b)	3.094	3.143	2.774	2.588
Intercept (a)	-2.201	-2.298	-1.838	-1.660
Correlation coefficient (r^2)	0.940	0.877	0.863	0.769
Growth pattern	Isometric	+ Allometric	- Allometric	- Allometric

Values are given as minimum-maximum (mean±standard error)

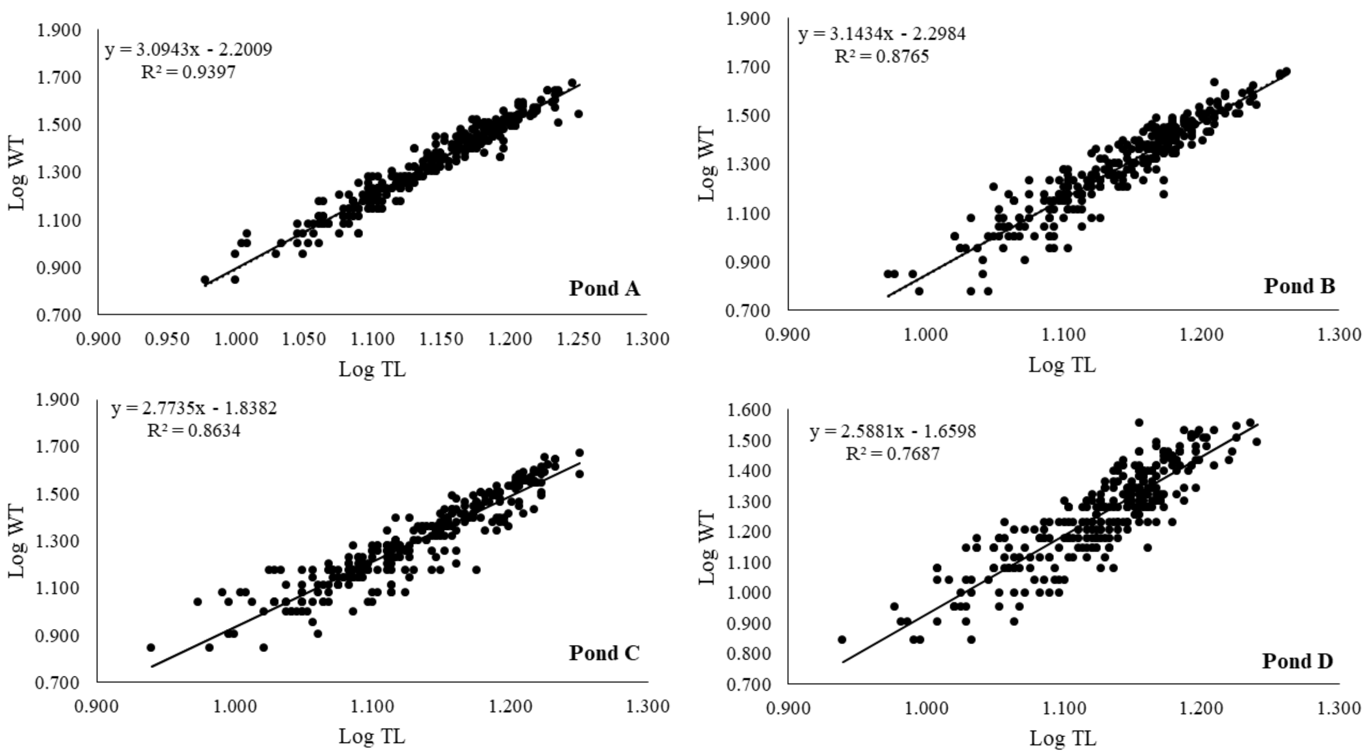

Figure 1 Growth coefficient of shrimp cultured in different earthen ponds

The condition factor (K) reflects the variations and information on physiological state of fish in relation to welfare. In present study, it was observed 0.591-1.037 (0.811±0.005) in pond A, 0.439-1.139 (0.742±0.006) in pond B, 0.444-1.324 (0.815±0.007) in pond C and 0.459-1.231 (0.765±0.008) in pond D respectively (Table 1). These resulted values of K were close to one which indicated that the condition of studied shrimp population was good and aquatic environment of earthen ponds was conducive for the culture of shrimp. Similar finding was reported by Kunda et al. [26] in *P.penicillatus* and Solanki et al. [9] in *P. monodon* whereas, K values >1.0 was reported in *P.monodon* [36, 37] and in *L. vannamei* [25, 33].

The statistical evaluation (ANOVA) showed significant variations (0.05 level of significance) in length, weight and condition factor of shrimp which were cultured in four different earthen ponds A, B, C and D respectively (**Table 2**). The significant differences in these morphometric (length and weight) and growth parameters (condition factor and growth constant) could be associated with the farming operations adopted by the farmer for the shrimp culture at the farm. Therefore, the study could suggest shrimp farmers to adopt the Best Management Practices (BMP) at uniform level in their ponds for the optimum and economic yield of shrimp.

Table 2 ANOVA for Length, Weight and Condition factor

Parameters		Sum of Squares	df	Mean Square	F	Sig.
Total length (cm)	Between Groups	60.504	3	20.168	6.895	0.000*
	Within Groups	3498.096	1196	2.925		
	Total	3558.600	1199			
Weight (g)	Between Groups	2619.276	3	873.092	13.422	0.000*
	Within Groups	77800.883	1196	65.051		
	Total	80420.159	1199			
Condition factor (K)	Between Groups	1.140	3	0.380	29.581	0.000*
	Within Groups	15.364	1196	0.013		
	Total	16.504	1199			

* Significance level 0.05%

Conclusion

The findings of study concluded that the growth of the shrimp in those studied ponds were satisfactory and condition of the shrimp was good in cultured ponds indicating good environmental condition of the ponds. But the significant variation in morphometric (length and weight) and growth parameters (condition factor and growth constant) depicted the unjustified farm operations and ultimately the shrimp production in all ponds were not uniform. So, on the basis of the findings of current study, application of best management practices in justified way to obtain good and economic production.

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