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EFFECT OF DIFFERENT STOCKING DENSITIES ON THE GROWTH AND SURVIVAL OF WHITE LEGGED SHRIMP WITH RED STRAIN TILAPIA UNDER POLYCULTURE SYSTEM

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ABSTRACT
The present study was conducted to assess the growth performance of pacific white shrimp (*P. vannamei*) with red strain tilapia under different stocking densities in indoor rearing. The red strain tilapia fingerlings were acclimatized to live in seawater salinity (35 ppt) by the 40th day of rearing. This experiment was conducted in indoor cement tanks (1.5 × 1.5 × 0.8 m) to observe growth performance of pacific white shrimp with red strain tilapia comprising six treatments and one control) with duplicates. This experiment was conducted for 60 days duration. The mean weight gain of *Penaeus vannamei* post larvae and red strain tilapia fingerlings reared in seawater showed highly significant positive correlation ($p < 0.001$) with days of rearing. Two way ANOVA of the data collected clearly affirmed that between different stocking densities and mean body weight gains of *Penaeus vannamei* and red strain tilapia fingerlings under seawater with days of rearing had significant difference. From this study, among the different stocking densities used for red strain tilapia fingerlings with *Penaeus vannamei* under polyculture indoor rearing, stocking density of 60 red strain tilapia/m^2 exhibited higher growth.

INTRODUCTION

Polyculture fits the principles of sustainable aquaculture, which aims at reducing the environmental impact of the activity by improving feeding efficiency and increasing income by rearing together two or more species (Cohen & Raanan, 1983; Wohlfarth *et al.*, 1985; Arana, 2004).

Many research areas have been conducted to increase profitability in aquaculture under polyculture, which can considerably improve farm production yields (Bardach *et al.*, 1972; Landau, 1992; Ponce - Marban *et al.*, 2006). Polyculture improved shrimp growth and quality (Akiyama and Angawati, 1999; Cruz-Suarez *et al.*, 2010), raised production and economic benefits and reduced environmental impacts (Garcia-Perez *et al.*, 2000; Tian *et al.*, 2001; Yuan *et al.*, 2010).

Tilapias are among the most important commercial freshwater fish species in the tropics. (Ahmed H. Alharbi, 2011). Tilapia represents a strong candidate for polyculture with shrimp because of its high resistance to adverse conditions, commercial demand and feeding habits (Martinez-Porchas *et al.*, 2010). Tilapia - shrimp polyculture with appropriate feeding strategy is technically feasible, economically attractive and environmentally friendly (Yuan *et al.*, 2010). Tilapia is often co-cultured with shrimps, in a wide range of salinity levels (from 0 to 30 ppt.), where the system either utilizes water from separate tilapia culture ponds and reservoirs, or tilapia are being stocked in cages inside shrimp ponds or even mixed in the same ponds (Akiyama and Anggawati, 1999; Yi and Fitzsimmons, 2004; Lio-Po *et al.*, 2005).

All these reports clearly indicated that shrimp performance is enhanced by the presence of a secondary species. There is paucity of information is available on polyculture of pacific white shrimp with red strain tilapia. With this background, the present research work was conducted to acclimatize tilapia fingerlings from freshwater to seawater and growth experiments of pacific white shrimp (*P.vannamei*) with red strain tilapia under different stocking densities in indoor rearing.

MATERIALS AND METHODS

A raceway cement tank (1.5 m × 1.5 m × 0.80 m/Area: 2.25 m^2/Volume: 1.80 m^3) was used for acclimatization of seeds. The indoor growth experiment was carried out in Mariculture Research Farm Facility (MRFF), an Unit of Department of Aquaculture located at Tharuvaikulam coastal village, Thoothukudi District, Tamil Nadu. The set up comprised of 6 sets of treatments and 1 sets of control. Each treatment & control set up has duplicates. A total of 14 cement tanks (6 Treatment + 1 Controls x 2 tanks) were used. Each cement tank has the size of 1.50 m × 1.5 m × 0.8 m with area of 2.25 m^2 and volume of 1.8 m^3. Before starting the experiment, these cement tank were washed with soap oil and cleaned well with seawater. Filtered seawater was filled in these cement tanks up to ¾ of its volume. All the cement tanks were provided with proper aeration facility. In each centre portion of the cement tank, one hapa has been fixed (Size: 45 cm Length x 60 cm Width x 60 cm Height).

Every day, the shrimp PL was fed with commercial shrimp pellet feed @ 6.5% (1-15 days), 4.3% (16-30 days), 4% (31-45 days) and 3.2% (46-60 days) based on the total body weight and offered 3 thrice a day (9 am, 1 pm & 4 pm). Similarly, every day, the red strain tilapia fingerlings were fed with commercial shrimp pellet feed @ 5% of the total body weight and offered 2 twice a day (11 am and 3 pm). This experiment was conducted for 60 days duration. Fish and shrimp sampling was done once in every 7 and 15 days respectively. The water quality parameters have been analyzed once in 15 days (APHA, 2005). Based on the information derived from biological data, individual statistical relationship such as Correlation, two way ANOVA of different experimental shrimps juvenile and red strain tilapia fingerlings maintained on different dietary regimes were analysed following the Bio-statistical Method of Christenson (1996) and Microsoft Excel.

RESULTS AND DISCUSSION

By gradual adding of seawater in freshwater, on an average, 3 ppt was increased once in 3 days. The red strain tilapia fingerlings (0.4 g ± 0.02) were acclimatized to live in seawater salinity (35 ppt) by the 40th day of rearing (4 g ± 0.20). Afterwards, tilapia fingerlings were maintained in seawater conditions for one week. The entire water was exchanged with complete seawater from the 3th day onwards. During the entire course of the acclimation, red strain tilapia fingerlings did not show any sign of distress, their feeding and swimming. All other activities remained normal. Abdel – Fattah M.El-Sayed (2006) also recorded that 04 days were required to acclimatize the tilapia fingerlings from freshwater (0 ppt) to seawater (35 ppt). The duration taken to acclimatize the tilapia fingerlings from freshwater (0 ppt) to seawater was 05 days as reported by Athithan et al (2011) and Rajeev Ranjan & Athithan (2016). Lende *et al.* (2015) reported that cotton seed meal replacing 30% of fish meal and soybean meal replacing 40% of fish meal in the diet of *O. mossambicus* advance fry gave better growth.

The bio growth parameters recorded for pacific white shrimp (*P. vannamei*) with red strain tilapia fingerlings under different stocking densities in indoor systems is given in Table 1. The mean weight gain (g) of pacific white shrimp in different treatments and control recorded were T1 (7.33 g ± 0.37), T2

Table 1: Bio growth parameters recorded for pacific white shrimp (*P.vannamei*) with red strain tilapia fingerlings under different stocking densities in indoor rearing

Parameters	Control(C)	Treatments (Shrimp + Tilapia)					
	Shrimp Alone	T1	T2	T3	T4	T5	T6
Stocking density (Numbers/tank)	120	120 + 2	120 + 4	120 + 6	120 + 8	120 + 10	120 + 12
Mean Initial weight (g) (*P. vannamei*)	0.07±0.05	0.07±0.03	0.08±0.004	0.09±0.04	0.08±0.04	0.09±0.04	0.10±0.005
Mean final weight (g) (*P.vannamei*)	7±0.35	7.40±0.37	8.30±0.43	9.20±0.46	10.40±0.52	11.20±0.56	12.30±0.615
Mean weight gain (g)(*P.vannamei*)	6.93±0.35	7.33±0.37	8.22±0.41	9.11±0.46	10.32±0.52	11.11±0.55	12.2±0.61
Mean initial weight (g) (Red strain tilapia)	-	0.4±0.02	0.2±0.01	0.3±0.015	0.25±0.01	0.35±0.017	0.40±0.02
Mean final weight (g) (Red strain tilapia)	-	54±2.7	72±3.6	90±4.5	108±4.3	132±4	156±3.12
Mean weight gain (g) (Red strain tilapia)	-	53.6±2.68	71.8±3.59	89.7±4.49	107.75±5 .40	131.65±6.60	155.6±7.78
Days of experiment (days)	60	60	60	60	60	60	60
Average daily growth rate ADG (g/day) (*P. vannamei*)	0.11	0.12	0.14	0.15	0.17	0.18	0.20
Average daily growth rate ADG (g/day)(Red strain tilapia)	-	0.89	1.20	1.49	1.79	2.19	2.59
Number of *P. vannamei* survived (numbers)	96	96	96	120	120	120	120
Survival rate (%) (*P. vannamei*)	80	80	80	100	100	100	100
Number of tilapia survived (numbers)	-	2	4	6	8	10	12
Survival Rate (%) (Red strain tilapia)	-	100	100	100	100	100	100
Total feed consumed (kg) (*P.vannamei*)	1.064	1.1970	1.2624	1.749	1.858	1.866	1.903
Net Weight Gain (kg) (*P.vannamei*)	0.665	0.704	0.789	1.093	1.238	1.333	1.464
Feed conversion ratio (FCR) (*P. vannamei*)	1.6	1.7	1.6	1.6	1.5	1.4	1.3
Total feed consumed (kg) (Red strain tilapia)	-	0.172	0.431	0.753	1.121	1.856	2.2555
Net weight gain (kg) (Red strain tilapia)	-	0.1072	0.287	0.538	0.862	1.326	1.879
Feed conversion ratio (FCR) (Red strain tilapia)	-	1.6	1.5	1.4	1.3	1.4	1.2

Table 2: Correlation between different stocking densities and mean body weight gains of *Penaeus vannamei* under seawater with days of rearing

S.No.	Days of culture (X)	Mean weight gain (Y)	df	Intercept value (a)	Slope(b)	Correlation coefficient (r)	P value	LS
Treatment 1	28.5556	3.5133	7	-0.0225	0.1238	1	P<0.001	S
Treatment 2	28.5556	3.8822	7	0.0539	0.1375	1	P<0.001	S
Treatment 3	28.5556	6.5851	7	-0.0278	0.1539	1	P<0.001	S
Treatment 4	28.5556	6.5851	7	-0.0370	0.1742	1	P<0.001	S
Treatment 5	28.5556	6.5852	7	-0.0348	0.1875	1	P<0.001	S
Treatment 6	28.5556	6.5858	7	-0.0405	0.2059	1	P<0.001	S
Control	28.5556	6.5852	7	-0.0203	0.1171	1	P<0.001	S

Table 3: Correlation between different stocking densities and mean body weight gains of Red strain tilapia under seawater with days of rearing

S. No.	Days of culture(X)	Mean weight gain(Y)	df	Intercept value (a)	Slope(b)	Correlation coefficient (r)	P value	LS
Treatment 1	30.20	27.08	3	0.9067	- 0.3012	1	P < 0.01	S
Treatment 2	30.20	35.32	3	1.1890	- 0.5881	0.9985	P < 0.01	S
Treatment 3	30.20	44.16	3	1.4856	- 0.7049	0.9985	P < 0.01	S
Treatment 4	30.20	54.05	3	1.8207	- 0.9339	0.9999	P < 0.01	S
Treatment 5	30.20	66.07	3	2.2247	- 1.1146	0.9999	P < 0.01	S
Treatment 6	30.20	78.08	3	2.6293	- 1.3255	0.9999	P < 0.01	S

Table 4: Two Way ANOVA between different stocking densities and mean body weight gains of Red strain tilapia under seawater with days of rearing

Source of variation	Two way ANOVA SS	df	MS	F	P-value	F crit
Rows (between days)	38418.36	4	9604.589	41.815	0.00049	2.866081
Columns (between treatments)	9171.46	5	1834.292	7.985861	0.021	2.71089
Error	4593.849	20	229.6924			
Total	52183.66	29				

(8.22 g ± 0.41), T3 (9.11 g ± 0.46), T4 (10.32 g ± 0.52), T5 (11.11 g ± 0.55), T6 (12.2 g ± 0.61) and C (6.93 g ± 0.35). The mean weight gain (g) of red strain tilapia fingerlings in different treatments and control recorded were T1 (53.6 g ± 2.68), T2 (71.8 g ± 3.59), T3 (89.7 g ± 4.49), T4 (107.75 g ± 5.40), T5 (131.65 g ± 6.60) and T6 (155.6 g ± 7.78). The calculated FCR of pacific white shrimp in different treatments & control were found to T1 - 1.7 , T2 - 1.6 , T3 - 1.6 , T4 - 1.5, T5 - 1.4 , T6 - 1.3 and C - 1.6. The feed conversion ratio of the red strain tilapia fingerlings in different treatments was found to be T1 - 1.6, T2 - 1.5, T3 - 1.4, T4 - 1.3, T5 - 1.4 and T6 - 1.2.

The correlation between different stocking densities and mean body weight gains of *Penaeus vannamei* and red strain tilapia fingerlings under seawater with days of rearing is given in Table 2 and Table 3 and showed highly significant positive correlation ($p < 0.001$) with days of rearing.

The Two Way ANOVA between different stocking densities and mean body weight gains of *Penaeus vannamei* under seawater with days of rearing is given in Table 4. Two way ANOVA of the data collected clearly affirmed that between different stocking densities and mean body weight gains of *Penaeus vannamei* under seawater with days of rearing had significant difference among the different experimental diets (Table 4).

Suresh (1999) reported that under favourable environmental conditions tilapia can produce 30 - 40 g in the range of 2 - 4 months, which means a gain of 0.5 g / day. In the present study also, the weight gain of red strain tilapia was higher under polyculture than Suresh (1999) reported under monoculture. The higher growth is due to polyculture advantage than monoculture rearing.

In an intensive shrimp farm to a low salinity mentioned that tilapia introduced in a mixed culture with shrimp, tilapia reached a weight between 341 and 679 g, with 1.6 of FCR and survival of 78%, while shrimp averaged 13 g at 123 days and 57% survival (Ortega-Salas, 2013). In the present study also, the weight gain of red strain tilapia was similar with Ortega-Salas (2013) reported under polyculture. In the case of shrimps, the average daily growth was higher than Ortega-Salas (2013) reported under polyculture.

From this study, among the different stocking densities used for red strain tilapia fingerlings with *Penaeus vannamei* under polyculture indoor rearing, stocking density of 60 red strain tilapia / m^2 exhibited higher growth (red strain tilapia: 155.6 g ± 7.78 / *Penaeus vannamei*: 12.20 g ± 0.61).

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