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Original Article

Effect of Different Stocking Density Ratios between Red Hybrid Tilapia and Fresh Water Prawn, *M. rosenbergii*, Post Larva on Performances

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Abstract

This study aimed to evaluate the growth performance, feed and nutrient utilization; survival rate and carcass composition of polyculture of red hybrid tilapia (*Oreochromis* sp.) (RT) and fresh water prawn, *M. rosenbergii*, post larva (FWP) at five different stocking densities ratios: 1:2, 1:3, 1:4, 1:5 and 1:6 (1 RT: 2 FWP) against control as (1 RT: 0 FWP) which known as monoculture. The initial individual biomass for fish and prawn were 1.87 ± 0.01^a g and 0.25 ± 0.01^a g, respectively. Feed was provided based on fish requirements. The experiment was conducted at the Animal and Fish Production Department, Faculty of Agriculture (EL-Shatby), Alexandria University, Egypt, in a completely randomized design with five treatments and two replicates each. Water quality parameters, salinity, temperature, dissolved oxygen, pH, ammonia, nitrate and nitrite were monitored. The experiment lasted 84 days and biomass gain was evaluated every two weeks. Final biomass, survival rate and feed conversion rates were calculated at the end of the experiment. The maximum value (35.80 ± 0.34) was recorded with stocking density ratio contained proportion (1:4) and the minimum value (18.22 ± 0.66) occurred with stocking density ratio contained proportion (1:6). These two species can be cultured together, without competing for the same resources, because they have different trophic niche, thus increasing productivity and economic returns for the farmers.

Key Words: *Aquaculture, hybrid, growth performance, carcass composition.*

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Introduction

Polyculture fits the principles of sustainable aquaculture, since it aims at reducing the environmental impact of the activity by improving feeding efficiency and increasing producer income by rearing together two or more species that do not compete for the same feed resources (Cohen and Ra'anan, 1983; Wohlfarth *et al*., 1985; Arana, 2004).

In addition, polyculture can also improve water quality, since in monoculture farming systems, the excess nutrients that result from uneaten feed increases the phytoplankton, which, in turn, changes the dissolved oxygen dynamics and brings negative ecological impact to the aquaculture activity itself (Midlen & Redding, 1998; Lutz, 2003; Henry-Silva & Camargo, 2008). Therefore, one of the benefits of polyculture is the ability to reduce the pollution resulting from the farming activity, since the residue existing in the ponds can be used by the second species being cultivated. Yang and Kevin (2010) revealed that shrimp production and economic returns from the two simultaneous polyculture systems and in sequential polyculture systems were higher than those in their respective shrimp monoculture systems practiced previously. Also shrimp production and economic returns from these polyculture systems were higher than those in the crop rotation polyculture system and in the currently practiced monoculture system. For many farmers, tilapia-shrimp polyculture could improve water quality in shrimp ponds, reduce diseases, and reduce the use of chemicals. In the direct style of tilapia-shrimp polyculture, about 40% farmers believed that tilapias compete for feed with shrimp, while the remaining 60% were not aware of such feed competition. Despite rapid development, shrimp farming in the Northeast has grown mainly focused on rearing a single species, thus leaving the producers without alternatives to tackle eventual environmental, social and economical problems that should arise. It should be noted that the infrastructure in place for the culture of fresh water shrimp can also be used for polyculture with tilapia with minor adaptations in the ponds or culture strategy (Bessa Junior *et al*, 2010). Therefore, the main objective of this study is to evaluate the performance parameters and economic feasibility of a red hybrid tilapia (*O. niloticus*) and fresh water prawn, *M. rosenbergii*, post larva polyculture at different stocking densities.

Material and Methods

The experiment was conducted at Animal and Fish Production Department, Faculty of Agriculture (EL-Shatby), Alexandria University, Egypt. Experiments were conducted in small scale of glass aquaria with dimensions of 100×40×30 cm and 100 l capacity of water /aquarium, two replicates per treatment were used in the present study. Each aquarium was cleaned daily in order to prevent accumulation of fecal materials and reduce the growth of algae, and the same amount of fresh water was used to refill the aquaria. During the lab experiment, water was partially changed once every three days using fresh water. Aeration was continuously provided using an air blower; water temperature was measured by using digital thermometer. Total ammonia, nitrate and nitrite were measured biweekly using a DREL, 2000 Spectrophotometer, dissolved oxygen was measured by using digital DO2 meter and pH was measured by using an electronic pH meter.

The experimental treatments consisted of five polycultures, where tilapia density remained constant (10 tilapias. 100L), but prawn was introduced at densities of 20, 30, 40, 50 and 60 prawns. 100L. Tilapia was considered the main culture, and feed was supplied based on the biomass and nutritional requirements of the fish. Dry feed containing 45% crude protein was supplied during the first 30 days of culture and, thereafter, extruded feed also containing 45% crude protein was offered three times daily, the daily feed ration for red hybrid tilapia (*Oreochromis* sp.) fry and prawns PL were computed every two weeks based on estimated body weight, at a feeding rate of 5%, feeding rate of 20% in first month, 15% in second month and 10% in third month, according to Poadas (2004). The daily ration was fed 6 days a week for 12 weeks depending on previous results of Kabir Chowdhury *et al*., (2007). The initial biomass (initial weight) of tilapia and prawn were 1.87 ± 0.01[a] g and 0.25 ± 0.01[a] g, respectively.

Table 1. Percentage composition of the artificial diet consumed by the prawn and fish cultivated in lab experiments.

Ingredient	45% crude protein	
	gm / kg	Percentages /kg
Fish meal	350	35
Soybean	350	35
Rice bran	140	14
Yellow	110	11
Yellow	30	3
Vit.	10	1
Min.	10	1

Body composition analysis

At the start of the experiments, twenty fish and prawn were collected, immediately frozen and reserved for initial body proximate chemical analysis. At the end of each treatment, all fish and prawn in each aquarium were netted, weighed, frozen and kept for final body composition analysis. Fish samples were pulverized, and homogenized with Ultra-Tunax. The homogenized samples were oven dried at 60 - 80°C for 48 hrs. Proximate analyses of the whole body protein, lipid, and ash were performed according to standard methods described by **AOAC (2000)** as follows**:**

Moisture content.To study moisture content, samples were dried in an oven adjusted at 105˚c overnight and the loss in weight was reported as percentage of moisture.

Crude Protein (CP) Kjeldahl method was applied to determine total nitrogen content in feed and fish samples. The factor of 6.25 was used to estimate crude protein according to **ISO, (1979).**

Ether extracts (EE).To study ether extract Soxhelt apparatus operated with electric heater and provided with water condenser was utilized. Extraction of the fat contents has been carried out for 3 hours using petroleum ether as solvent according to **Folch *et al*., (1956).**

Crude fibers (CF).Samples were treated with boiling in H_2SO_4 then NaOH 12.5% w/w for 10 minutes, each solution volume was kept constant by addition of boiling water. Final residues were washed by 5% HCL to get rid of adhering NaOH, and then they filtered dried weight ashes at 550˚c for 2 hours.

Ash content.Ash contents were determined by incineration at 550˚c in muffle furnace for 2 hours.

Nitrogen free extract in the experimental diets was calculated by using the following equation:

NFE=100- (Moisture + CP + EE + CF)

Where:

NFE= Nitrogen free extract.
CP= Crude protein.
EE=Ether extract.
CF= Crude fiber.

Gross energy (GE)

Gross energy of diets was calculated according to the gross caloric values of **NRC (1993)** using the values of 5.64, 9.44 and 4.11 kcal /g diet crude protein, crude fat and total carbohydrate, respectively. Survival rate, expressed in percentage, was calculated based on the amount of harvested animals divided by the number of stocked individuals and multiplied by 100.

Survival rate SR (%) = (n end/ n initial) ×100

Measurement of growth

Total weight gain, average daily gain, specific growth rate, feed conversion ratio protein and energy utilization were determined according to **Recker, (1975) and Castell and Tiews, (1980)** as follow:

1- Total gain (g/fish) = $(W_T - W_I)$.

Where:

W_T= Final means weight of fish in grams.
W_I= Initial means weight of fish in grams.

2- Average daily gain (ADG) (g/fish/day) = total gain / duration period.

3- Specific growth rate (SGR) % / day) = 100 × (Ln W_T - Ln W_I) / duration period.

Where:

Ln= Natural log and n is the duration period in days.

Measurement of feed and nutrient utilization

1- Feed conversion ratio (FCR) = dry matter intake (g) / total gain (g).

2- Protein efficiency ratio (PER) = total gain (g) / protein intake (g).

3- Protein productive value (PPV %) = (P_T – P_I) ×100 / protein intake (g).

Where:

P_T= Protein content in fish carcass at the end.

P_I= Protein content at the start.

4- Energy utilization (EU %) = (E_T–E_I) ×100 / Energy intake (kcal).

Where:

E_T= Energy in fish carcass (kcal) at the end.

E_I= Energy in fish carcass (kcal) at the start.

Statistical analysis

Statistically analyzed data was done using two-way classification (Factorial design 2 ×3) using the feature PROC UNIVARIATE of the software SAS (Statistical Analysis System, version 6.10). Duncan's multiple range test was used to compare differences between treatment means when significance F values were observed Duncan, (1955), at P ≤ 0.05 level. Data were submitted to analysis of variance (two-way ANOVA) to identify significant differences (P<0.05) between treatments.

Results

Water quality

Water quality parameters recorded during the experimental period were within the following ranges:

1- Dissolved oxygen: it was varied from 5.5 to 14.0 mg/L.

2- Water temperature: it was varied from 27 to 32 °C.

3- Hydrogen ion concentration (pH): it was fluctuated between 7.0 and 8.5.

4- Ammonia: it was varied from 0.01 to 1.00 ppm.

5- Nitrate: it was fluctuated between 0.50 to 1.30 ppm.

6- Nitrite: it was varied from 5 to 10 ppm.

7- Salinity: it was varied from 2 to 3.5‰

The basal experimental diet was formulated to contented 44.04% CP, 5.08% crude fat, 29.02% total carbohydrate, 415.90 (kcal/100g) gross energy (GE) and 105.89 (mg CP /kcal GE) protein energy ratio (P:E ratio) according to Teshima *et al*. (2006).

(A) Fresh water prawn *M. rosenbergii*, post larva

The final weight obtained by the prawn fed diets contained (1RT:4FWP), (1RT:3FWP) and (1RT:2FWP) proportion is significantly at (P<0.05) higher than the prawn fed the same diets with other proportion as (1RT:5FWP) and (1RT:6FWP) being 8.66 ± 0.05, 7.35 ± 0.05 and 6.74 ± 0.07 respectively in the formers and 4.18 ± 0.07 and 2.62 ± 0.15 respectively in the latter's. In general, the maximum value (8.66 ± 0.05) was recorded with stocking density contained proportion (1RT:4FWP) and the minimum value (2.62 ± 0.15) occurred with stocking density contained proportion (1RT:6FWP).

The best average daily gain (0.12 ± 0.01 g/prawn/day) was obtained with stocking density contained proportion (1RT:4FWP). However, no significant differences (P>0.05) were observed between stocking density contained proportion (1RT:3FWP) and (1RT:2FWP) as (0.09 ± 0.01 g/prawn/day). Results of specific growth rate (% day) showed that highly significantly difference at (P>0.001) between data. The specific growth rate (% day) obtained by stocking density proportion (1RT:4FWP), (1RT:3FWP) and (1RT:2FWP) are significantly at (P<0.001) higher than the prawn (PL) fed the same diet with other stocking density proportion (1RT:5FWP), (1RT:6FWP); being 4.22 ± 0.03, 4.05 ± 0.03 and 3.90 ± 0.01 respectively in the formers and 3.36 ± 0.03 and 2.80 ± 0.02 respectively in the latter's.

The highest protein intake was obtained by FWP with stocking density proportion (1RT:2FWP), (1RT:4FWP) and (1RT:3FWP) and the lowest in the proportions of (1RT:5FWP) and (1RT:6FWP); being 11.05 ± 0.69, 9.41 ± 1.00b and 7.89 ± 1.00 in the former and 6.13 ± 0.16 and 2.82 ± 0.09 in the latter.

Table 2. Effect of five different stocking density ratios between red hybrid tilapia (*Oreochromis sp*.) and the fresh water prawn, *M. rosenbergii*, post larva on the growth performance

Treatment	Body weight		Total weight gain (g/fish &pl)	Average daily gain (ADG) (g/fish &pl /day)	Specific growth rate (SGR) (%/day)
	Initial (g/fish &pl)	Final (g/fish &pl)			
Type of animal (TA)					
Red Tilapia(RT)	1.87[b]	27.15[a]	25.29[a]	0.30[a]	3.16 [b]
Prawn(p)	0.25[a]	5.91[b]	5.67 [b]	0.07[b]	3.66 [a]
Stocking density (SD) P:T					
(1:2)	1.06 ± 0.46[a]	16.98±5.91[c]	15.92 ± 5.45[c]	0.20 ± 0.06[c]	3.55 ± 0.21[c]
(1:3)	1.06 ± 0.47[a]	18.76±6.59[b]	17.70 ± 6.12[b]	0.22 ± 0.07[b]	3.68 ± 0.21[b]
(1:4)	1.06 ± 0.46[a]	22.23±7.84[a]	21.20 ± 7.36[a]	0.26 ± 0.08[a]	3.87 ± 0.20[a]
(1:5)	1.06 ± 0.47[a]	13.18±5.19[d]	12.12 ± 4.73[d]	0.14 ± 0.06[d]	3.15 ± 0.12[d]
(1:6)	1.06 ± 0.47[a]	10.42±4.51[e]	9.36 ± 4.05[e]	0.12 ± 0.05[e]	2.75 ± 0.03[e]
(SD)*TA					
Control (1:0)RT	1.87 ± 0.01[a]	29.35±0.34[b]	27.49 ± 0.33[c]	0.32 ± 0.01[c]	3.28 ± 0.01[c]
(1:2)RT	1.87 ± 0.01[a]	27.21±0.33[c]	25.35± 0.34[d]	0.31 ± 0.01[c]	3.19 ± 0.02[d]
(1:3)RT	1.87 ± 0.01[a]	30.17±0.70[b]	28.30±0.69[b]	0.34 ± 0.01[b]	3.31 ± 0.02[b]
(1:4)RT	1.86 ± 0.01[a]	35.80±0.34[a]	33.94± 0.33[a]	0.41 ± 0.01[a]	3.53 ± 0.01[a]
(1:5)RT	1.87 ± 0.02[a]	22.17±0.28[d]	20.31±0.27[e]	0.24 ± 0.01[d]	2.95 ± 0.01[e]
(1:6)RT	1.87 ± 0.01[a]	18.22±0.66[e]	16.36± 0.66[f]	0.20 ± 0.01[e]	2.71 ± 0.04[f]
(1:2)P	0.26 ± 0.01[a]	6.74 ± 0.07[c]	6.49 ± 0.07[c]	0.09 ± 0.01[b]	3.90 ± 0.01[c]
(1:3)P	0.25 ± 0.01[a]	7.35 ± 0.05[b]	7.11 ± 0.06[b]	0.09 ± 0.01[b]	4.05 ± 0.03[b]
(1:4)P	0.25 ± 0.01[a]	8.66 ± 0.05[a]	8.45 ± 0.06[a]	0.12 ± 0.01[a]	4.22 ± 0.03[a]
(1:5)P	0.24 ± 0.01[a]	4.18 ± 0.07[d]	3.93 ± 0.06[d]	0.05 ± 0.01[c]	3.36 ± 0.03[d]
(1:6)P	0.25 ± 0.01[a]	2.62 ± 0.15[e]	2.37 ± 0.14[e]	0.04 ± 0.01[d]	2.80 ± 0.02[e]
L.S.D (P<0.05)	0.03	1.65	1.62	0.04	0.10

The mean in the same column bearing different superscript are significantly different at (P<0.05). Means followed by the same letter are not significant, but different letters are significant. L.S.D: Least Significant Difference.

Table 3. Analysis of variance (mean square) of growth performance parameter of the fresh water prawn, *M. rosenbergii*, post larva and red hybrid tilapia (*Oreochromis* sp.) with different treatments of stocking density

Analysis of variance (A.O.V)	Degree of freedom	Body weight		Total weight gain (g/fish &pl)	Average daily gain (ADG) (g/fish &pl /day)	Specific growth rate (SGR) (%/day)
		Initial (g/fish&pl)	Final (g/fish &pl)			
Treatment	11	1.30***	263.35***	230.51***	0.032***	0.45***
Error	10	0.0001	0.27	0.26	0.0001	0.001
Total	21	1.3001	263.62	230.77	0.0321	0.451

*** Denotes significant differences in data at (P< 0.001) level of probability respectively.

The highest feed conversion ratio was obtained by FWP with stocking density proportion (1RT:2FWP), (1RT:5FWP) and (1RT:6FWP) and the lowest in the proportions of (1RT:3FWP) and (1RT:4FWP); the proportions being 3.87 ± 0.28, 3.54 ± 0.04 and 2.71 ± 0.07 in the former and 2.52 ± 0.30 and 2.54 ± 0.30 in the latter. Results revealed significant differences in the energy content (kcal/100gm) among different stocking density treatments. The minimum values of energy content (kcal/100gm) were recorded with stocking density proportion (1RT:3FWP), (1RT:2FWP) and (1RT:6FWP) as 529.56 ± 0.04, 532.06 ± 0.14 and 533.61 ± 0.09 respectively and reached it maximum values (544.50 ± 0.04 and 534.26 ± 0.01 respectively) with FWP in stocking density proportion (1RT:4FWP)and(1RT:5FWP).

Table 4. Effect of different stocking density treatments on feed intake and nutrient utilizations of the fresh water prawn, *M. rosenbergii*, post larva and red hybrid tilapia (*Oreochromis sp.*)

Treatment	Feed intake (gm/fish &pl)	protein intake (gm/fish &pl)	Food conversion ratio (FCR)	Protein utilization		Energy utilization (EU%)
				Protein efficiency ratio (PER)	Protein productive value (PPV%)	
Type of animal (TA)						
Red Tilapia (RT)	79.09 [a]	34.83 [a]	3.16 [a]	0.74 [a]	11.50 [b]	12.60 [a]
Prawn (P)	16.93 [b]	7.46 [b]	3.04 [a]	0.78 [a]	11.92 [a]	11.28 [b]
Stocking density (SD) P:RT						
(1:2)	64.63± 22.87[a]	28.46±10.07[a]	3.99 ± 0.13[a]	0.57 ± 0.02[b]	9.64 ± 0.43[cd]	9.66 ± 0.68[c]
(1:3)	50.66± 18.94[c]	22.31± 8.34[c]	2.74 ± 0.18[c]	0.85 ± 0.06[a]	13.99± 0.71[b]	14.04± 0.71[b]
(1:4)	55.15±19.55[b]	24.29± 8.61[b]	2.58 ± 0.07[c]	0.89 ± 0.02[a]	15.49± 1.01[a]	15.32± 1.38[a]
(1:5)	44.11±17.43[d]	19.43± 7.68[d]	3.60 ± 0.05[b]	0.63 ± 0.01[b]	9.98 ± 0.18[c]	10.32± 0.63[c]
(1:6)	26.36± 11.58[e]	11.61± 5.10[e]	2.77 ± 0.05[c]	0.82 ± 0.01[a]	8.64 ± 2.34[d]	9.59 ± 1.49[c]
(SD)*TA						
(1:0)RT	77.40 ± 3.28 [c]	34.09±1.44 [c]	2.82± 0.08[cd]	0.81 ± 0.03[ab]	13.17± 0.11[b]	14.19± 0.45[b]
(1:2)RT	104.18± 2.39[a]	45.88± 1.05[a]	4.11 ± 0.04[a]	0.56 ± 0.01[c]	10.25± 0.20[c]	10.77± 0.14[c]
(1:3)RT	83.40 ± 1.65[b]	36.73± 0.73[b]	2.95 ± 0.13[c]	0.78 ± 0.04[b]	13.56± 0.15[b]	14.59± 0.22[b]
(1:4)RT	88.94 ± 2.90[b]	39.17± 1.28[b]	2.62 ± 0.06[d]	0.87 ± 0.02[a]	17.15± 0.34[a]	17.66± 0.42[a]
(1:5)RT	74.30 ± 0.66[d]	32.72± 0.29[d]	3.66 ± 0.08[b]	0.62 ± 0.01[c]	10.29± 0.07[c]	11.41± 0.05[c]
(1:6)RT	46.32 ± 2.67[e]	20.40± 1.18[e]	2.83± 0.05[cd]	0.81 ± 0.02[ab]	4.60± 0.11[d]	7.02 ± 0.15[d]
(1:2)P	25.08±1.57[a]	11.05± 0.69[a]	3.87 ± 0.28[a]	0.59 ± 0.04[c]	9.03 ± 0.59[c]	8.55 ± 0.58[b]
(1:3)P	17.92±2.27[bc]	7.89± 1.00[bc]	2.52 ± 0.30[b]	0.92 ± 0.11[a]	14.42± 1.64[a]	13.50± 1.55[a]
(1:4)P	21.36±2.27[ba]	9.41± 1.00[ba]	2.54 ± 0.30[b]	0.90 ± 0.11[a]	13.83± 1.64[a]	12.99± 1.55[a]
(1:5)P	13.92±0.37[c]	6.13± 0.16[c]	3.54 ± 0.04[a]	0.64 ± 0.01[bc]	9.67 ± 0.07[bc]	9.22 ± 0.06[b]
(1:6)P	6.40±0.20[d]	2.82 ± 0.09[d]	2.71 ± 0.07[b]	0.84 ± 0.02[ba]	12.68±0.26[ba]	12.16± 0.23[a]
L.S.D(P<0.05)	9.39	4.13	0.63	0.17	2.29	2.46

The mean in the same column bearing different superscript are significantly different at (P<0.05).
Means followed by the same letter are not significant, but different letters are significant. L.S.D: Least Significant Difference.

Results revealed that, values of crude protein, ash and energy content (kcal/100g) were very high significantly different at (P<0.001) but there is high significant difference at (P<0.01) in dry matter and ether extract content results among different stocking density ratios of FWP.

(B) Red hybrid tilapia (*Oreochromis* sp.)

The final weight obtained by the fish fed diets contained (1RT:4FWP), (1RT:3FWP) and (1RT:2FWP) proportion is significantly at (P<0.05) higher than the fish fed the same diets with other proportion as (1RT:5FWP) and (1RT:6FWP) being 35.80 ± 0.34, 30.17 ± 0.70 and 27.21 ± 0.33 respectively in the formers and 22.17 ± 0.28 and 18.22 ± 0.66 respectively in the latter's. In general, the maximum value (35.80 ± 0.34) was recorded with stocking density contained proportion (1RT:4FWP) and the minimum value (18.22 ± 0.66) occurred with stocking density contained proportion (1RT:6FWP) against control as (29.35±0.34).

Table 5. Analysis of variance (mean square) of feed and nutrient utilizations of the fresh water prawn, *M. rosenbergii*, post larva and red hybrid tilapia (*Oreochromis sp.*) with different treatments of stocking density

Analysisof variance (A.O.V)	Degrees of freedom	Feed intake (gm/fish&pl)	protein intake (gm/fish&pl)	(FCR)	Protein utilization		(EU%)
					(PER)	(PPV%)	
Treatment	11	2228.74***	443.85***	0.61***	0.03***	20.95***	17.03***
Error	10	8.77	1.70	0.04	0.003	0.52	0.60
Total	21	2237.51	445.55	0.65	0.033	21.47	17.63

*** Denotes significant differences in data at (P< 0.001) level of probability respectively.

Table 6. Effect of different stocking density on body composition and energy content of whole body parameter of the fresh water prawn, *M. rosenbergii*, post larva and red hybrid tilapia (*Oreochromis sp.*)

Treatment	Dry Matter%	% On dry matter basis			E. Content (Kcal/100g)
		C.P.	E.E.	Ash	
Type of animal (TA)					
Red Tilapia (RT)	28.10 ^{a}	55.27 ^{b}	28.89 ^{a}	15.27 ^{b}	571.50 ^{a}
Prawn (P)	25.39 ^{b}	59.99 ^{a}	20.76 ^{b}	19.24 ^{a}	534.80 ^{b}
Stocking density (SD) P:T					
(1:2)	26.71 ± 0.80 ^{c}	57.46±1.26 ^{c}	25.02 ± 2.40 ^{ab}	17.49 ± 1.16 ^{a}	560.95± 16.37 ^{c}
(1:3)	27.02 ± 0.89 ^{b}	57.97±1.23 ^{b}	24.75 ± 2.32 ^{bc}	17.09 ± 1.21 ^{b}	533.98 ± 2.55 ^{d}
(1:4)	27.51 ± 0.97 ^{a}	58.87±1.53 ^{a}	24.44 ± 2.46 ^{c}	16.70 ± 0.92 ^{c}	566.47± 12.69 ^{a}
(1:5)	26.52 ± 0.78 ^{cd}	57.15±1.30 ^{d}	25.23 ± 2.49 ^{a}	17.71 ± 1.13 ^{a}	561.06± 15.47 ^{b}
(1:6)	26.33 ± 0.70 ^{d}	56.97±1.35 ^{e}	25.22 ± 2.38 ^{a}	17.62 ± 1.15 ^{a}	560.41± 15.45 ^{c}
(SD)*TA					
Control (1:0)RT	27.39 ± 0.26 ^{e}	54.76±0.57 ^{e}	27.83 ± 0.07 ^{c}	14.65 ± 0.44 ^{b}	538.32 ± 0.69 ^{d}
(1:2)RT	28.09 ± 0.08 ^{c}	55.29±0.13 ^{c}	29.17 ± 0.24 ^{ba}	15.49 ± 0.17 ^{abc}	588.75 ± 0.30 ^{a}
(1:3)RT	28.56 ± 0.11 ^{b}	55.84±0.06 ^{b}	28.76 ± 0.03 ^{b}	15.01 ± 0.12 ^{c}	538.40 ± 0.08 ^{d}
(1:4)RT	29.18 ± 0.14 ^{a}	56.22±0.12 ^{a}	28.70 ± 0.02 ^{b}	15.11 ± 0.01 ^{bc}	588.45 ± 0.02 ^{ba}
(1:5)RT	27.85 ± 0.20 ^{cd}	54.90±0.06 ^{d}	29.53 ± 0.35 ^{a}	15.75 ± 0.26 ^{a}	587.86 ± 0.22 ^{b}
(1:6)RT	27.55 ± 0.01 ^{d}	54.64±0.01 ^{d}	29.34 ± 0.11 ^{ba}	15.63 ± 0.19 ^{ba}	587.22 ± 0.03 ^{c}
(1:2)P	25.33 ±0.12 ^{cb}	59.64±0.06 ^{c}	20.87 ±0.10 ^{ba}	19.49 ±0.01 ^{ba}	532.06 ± 0.14 ^{d}
(1:3)P	25.49 ±0.11 ^{b}	60.10±0.13 ^{b}	20.73 ±0.03 ^{b}	19.17 ±0.18 ^{b}	529.56 ± 0.04 ^{e}
(1:4)P	25.84 ± 0.11 ^{a}	61.51±0.13 ^{a}	20.19 ±0.03 ^{c}	18.30 ±0.18 ^{c}	544.50 ± 0.04 ^{a}
(1:5)P	25.18± 0.06 ^{cb}	59.41±0.09 ^{c}	20.93 ±0.05 ^{ba}	19.66 ±0.04 ^{a}	534.26 ± 0.01 ^{b}
(1:6)P	25.11 ±0.09 ^{c}	59.30±0.10 ^{c}	21.10 ±0.10 ^{a}	19.60 ±0.10 ^{a}	533.61 ± 0.09 ^{c}
L.S.D(P<0.05)	0.55	0.90	0.71	0.84	1.14

The mean in the same column bearing different superscript are significantly different at (P<0.05).
Means followed by the same letter are not significant, but different letters are significant.
L.S.D: Least Significant Difference.

The best average daily gain (0.41 ± 0.01g/fish/day) was obtained with stocking density contained proportion (1RT:4FWP). However, there are nearly similar in results were observed between stocking density contained proportion (1RT:3FWP) and (1RT:2FWP) as (0.34 ± 0.01 and 0.31 ± 0.01g/fish/day) against control as (0.32 ± 0.01).

Results of specific growth rate (% day) showed that highly significantly difference at (P>0.001) between data. The specific growth rate (% day) obtained by stocking density proportion (1RT:4FWP), (1RT:3FWP) and (1RT:2FWP) are significantly at (P<0.001) higher than the fish fed the same diet with other stocking density proportion (1RT:5FWP) and (1RT:6FWP); being 3.53 ± 0.01, 3.31 ± 0.02 and 3.19 ± 0.02 respectively in the formers and 2.95 ± 0.01 and 2.71 ± 0.04 respectively in the latter's against control as (3.28 ± 0.01).

The highest feed conversion ratio was obtained by the red hybrid tilapia (*Oreochromis* sp.) with stocking density proportion (1RT:2FWP), (1RT:5FWP) and (1RT:3FWP) and the lowest in the proportions of (1RT:4FWP) and (1RT:6FWP); the proportions being 4.11 ± 0.04, 3.66 ± 0.08 and 2.95 ± 0.13 in the former and 2.62 ± 0.06 and 2.83 ± 0.05 in the latter against control as (2.82± 0.08).

Results revealed significant differences in the energy content (kcal/100gm) among different stocking density treatments. The minimum values of energy content (kcal/100gm) were recorded with stocking density proportion (1RT:3FWP), (1RT:6FWP) and (1RT:5FWP) as 538.40 ± 0.08, 587.22 ± 0.03 and 587.86 ± 0.22 respectively and reached it maximum values (588.75 ± 0.30 and 588.45 ± 0.02 respectively) with the red hybrid tilapia (*Oreochromis* sp.) in stocking density proportion (1RT:2FWP) and (1RT:4FWP) against control as (538.32 ± 0.69).

Table 7. Analysis of variance (mean square) of body composition of the whole body of the fresh water prawn, *M. rosenbergii*, post larva and red hybrid tilapia (*Oreochromis sp*.) with different treatments of stocking density.

Analysis of variance (A.O.V)	Degrees of freedom	Dry Matter%	% On dry matter basis			Energy Content (Kcal/100g)
			Crude Protein	Ether Extract	Ash	
Treatment	11	4.12***	12.01***	33.14***	8.22***	1291.03***
Error	10	0.03	0.08	0.05	0.07	0.13
Total	21	4.15	12.09	33.19	8.29	1291.16

*** Denotes significant differences in data at (P< 0.001) level of probability respectively.

Results revealed that, values of dry matter, crude protein and energy content (kcal/100g) were very high significantly different at (P<0.001) but there is significant difference at (P<0.05) in ether extract and ash content results among different stocking density treatments of the RT.

(C) Interaction between Fresh water prawn, *M. rosenbergii*, post larva and Red hybrid tilapia (*Oreochromis* sp.)

The final weight obtained by the prawn fed diets contained (1RT:4FWP), (1RT:3FWP) and (1RT:2FWP) proportion is significantly at (P<0.05) higher than the fish fed the same diets with other proportion as (1RT:5FWP) and (1RT:6FWP) being 22.23 ± 7.84, 18.76

± 6.59 and 16.98 ± 5.91 respectively in the formers and 13.18 ± 5.19 and 10.42 ± 4.51 respectively in the latter's. In general, the maximum value (22.23 ± 7.84) was recorded with stocking density contained proportion (1RT:4FWP) and the minimum value (10.42 ± 4.51) occurred with stocking density contained proportion (1RT:6FWP).

Table 8. survival rate of red hybrid tilapia (*Oreochromis sp*.) and fresh water prawn, *M. rosenbergii*, post larva with five stocking density ratios against control

Treatments	Survival Rate (%) in Fresh water prawn	Survival Rate (%) in Red hybrid tilapia
Control (1:0)	0	90.00 ± 0.20[a]
(1:2)	65.00 ± 0.27[c]	90.00 ± 0.44[b]
(1:3)	73.33 ± 0.60[b]	90.00 ± 0.21[b]
(1:4)	80.00 ± 0.44[a]	100.00 ± 0.39[a]
(1:5)	62.00 ± 0.33[d]	80.00 ± 0.28[c]
(1:6)	48.33 ± 0.12[e]	70.00 ± 0.32[d]

The best average daily gain (0.26 ± 0.08 g/ prawn and fish /day) was obtained with stocking density contained proportion (1RT:4FWP). However, there are nearly similar in results were observed between stocking density contained proportion (1RT:3FWP) and (1RT:2FWP) as (0.22 ± 0.07 and 0.20 ± 0.06 g/ prawn and fish /day). The lower significant average daily gain was obtained by stocking density contained proportion (1RT:6FWP) and (1RT:5FWP) as (0.12 ± 0.05 and 0.14 ± 0.06 g/prawn and fish/day). The highest feed conversion ratio was obtained by RT and FWP with stocking density proportion (1RT:2FWP), (1RT:5FWP) and (1RT:6FWP) and the lowest in the proportions of (1RT:4FWP) and (1RT:3FWP); the proportions being 3.99 ± 0.13a, 3.60 ± 0.05 and 2.77 ± 0.05 in the former and 2.58 ± 0.07 and 2.74 ± 0.18 in the latter. Results revealed significant differences in the energy content (kcal/100gm) among different stocking density treatments. The minimum values of energy content (kcal/100gm) were recorded with stocking density proportion (1RT:3FWP), (1RT:6FWP) and (1RT:5FWP) as 533.98 ± 2.55, 560.41 ± 15.45 and 561.06 ± 15.47 respectively and reached it maximum value (566.47 ± 12.69) with RT and FWB in stocking density proportion (1RT:4FWP). Results revealed that, values of dry matter, crude protein ether extract, ash content and energy content (kcal/100g) were very high significantly different at ($P<0.001$) between different stocking density treatments of RT and FWP.

Discussion

Water temperature varied from 26 to 31, within the range recommended by Hsieh *et al*., (1989). Kubitza (2000) stated that the range of thermal comfort for tilapia lies between 27 and 32 ºC, very close to the values reported in this study, and that temperature outside this optimum range cause decreased appetite and growth. Although *M. rosenbergii* is tolerant of wide temperature ranges (18–34 ºC), temperatures ranging from 27 to 32 ºC are believed to be optimal (Daniels *et al*., 2000). The lowest and highest dissolved oxygen values observed were 5.5mg/L to 14.0mg/L in the morning and afternoon, respectively. The dissolved oxygen levels observed in both periods were above the values considered ideal for fish (5mg.L-1) and shrimp (3.5mg.L-1) growth (Ross & Ross, 1983; Boyd, 1990). Probably, these higher dissolved oxygen levels observed in the afternoon. *Macrobrachium rosenbergii* is stressed when DO falls below 2 mg O_2/L, and the lethal DO level for the prawns was found to be 0.5 mg O_2/L (Avault 1986). Hence, DO has often been considered an important environmental factor determining the success and intensification of prawn culture, and DO values higher than 5 mg /L have often been recommended for intensive culture practice Cheng *et al*., (2001).

Water pH varied between 7.0 to 8.5during the experimental period. Both species, fish and fresh water prawn, tolerate pH varying between 6.0 and 9.0 (Boyd, 1990; Arana, 1997), while the ideal and satisfactory pH ranges for fish farming varies from 7.0 to 8.5, and from 6.5 to 9.5 (Sipaúba- Tavares, 1994), respectively. Boyd (1990) stated that the optimal pH range for the growth of *Macrobrachium rosenbergii* is 7.0–8.5. However, nothing is known regarding the chronic effect of pH on *Macrobrachium rosenbergii.* is considered to be more sensitive to low pH as compared to other decapods crustaceans. Concerning the toxicity of pH to crayfish, adult prawns are more tolerant to low pH than juveniles Distefano *et al*., (1991). The minimum acceptable level of pH was 6.2 based on the growth of prawns in different pH levels after 42 days Allan and Maguire (1992). Therefore, the pH values of this study were within the recommended range for the culture of (RT) and (FWP). In general, the pH values changed very little between treatments. Salinity: it varied between 2.0 to 3.5during the experimental period. In *M. rosenbergii* can be reared in both freshwater and brackish water; that is, prawns kept in a wide range of salinities (0–24‰) are able to regulate their hemolymph osmolality and ion concentrations (Stern *et al*., 1987). While, most tilapia species are considered euryhaline, in other words, they are capable of with standing a wide range in salinity (Phililppart and Ruwet 1980). All tilapias are both osmotic and ionic regulators due to their external medium Jobling, (1994). Nile tilapia *O. niloticus* is considered less euryhaline than most species, but it can survive in bodies of water with salt concentrations equal to 30% of ocean water Philippart and Ruwet (1982) .While tilapia sp. that are euryhaline may be beneficial for producers, underlying problems related to salinity and growth can occur.

Water ammonia varied between 0.01to 1.00 ppm, nitrate varied between 0.50 to 1.30 ppm and nitrite varied between 5 to 10 ppm during the experimental period. Which similar with results of Boyed and Zimmermann (2000) recorded that, the optimum values of ammonia as (<2.00ppm), nitrate as (<10ppm) and nitrite as (<0.3ppm) for *M. rosenbergii*, fresh water prawn. In culture ponds, ammonia is the most common toxicant. The 24 and 144 h of LC50 (median lethal concentration) of ammonia on *M. rosenbergii* larvae is 115 and 40 mg l^{-1}, respectively (Armstrong *et al*., 1978). The main excretory products of fish are ammonia. In water the ammonia molecular reacts to form ammonia ion (NH_4) which is fairly innocuous to fish, whereas free ammonia (NH_3) is highly toxic and a level of 0.03 mg /L is generally regarded as the maximum acceptable limit for tilapia. Alfred and Michael (1983) found that the high standing crops of tilapia have caused high ammonia levels at 13 - 43 mg /L. Excretion from fish might largely be responsible for these high levels, but the decay of some unconsumed feed might be attributed to this particularly. Generally, the polyculture with shrimp, regardless of the density, significantly affect mean individual tilapia biomass. The mean final biomass values for the RT were 29.35±0.34 g (1RT:0FWP), 27.21±0.33 g (1RT:2FWP), 30.17±0.70 g (1RT:3FWP), 35.80±0.34 g (1RT:4FWP), 22.17±0.28 g (1RT:5FWP) and 18.22±0.66 g (1RT:6FWP). Candido *et al*. (2006), who studied *O. niloticus* and *L. vannamei* polyculture in fresh water during 120 days, reported mean values of individual final biomass of 226.68 (2T:4S), 220.43 (2T:8S) and 257.00 g (2T:12S). This higher mean individual biomass compared with the present study is probably due to a longer rearing period, different in species and rearing in semi natural field as ponds.

The prawn individual biomass values were significantly different between treatments and over time as well, from (1RT:4FWP) until (1RT:6FWP) proportion. In general, prawn individual biomass decreased as the stocking density increased. Prawn individual biomass was significantly higher for treatment (1RT:4FWP) (8.66 ± 0.05 g) compared with treatments (1RT:3FWP) and (1RT:2FWP) as

(7.35 ± 0.05 g) and (6.74 ± 0.07g) respectively which similar with Wohlfarth *et al*. (1985) concluded that fish and shrimp growth rates are not interdependent in polyculture systems. Some studies have shown that in polyculture, the development of shrimp is more influenced by their own population density than the density of fish populations (New, 1995). In fact, in the present study, high shrimp stocking densities (1RT:5FWP and 1RT:6FWP) yielded final individual biomass values significantly lower compared with low shrimp density (1RT:4FWP). This fact was probably related to the reduced feed supply and/or intraspecific competition in aquaria where shrimp density was high. Santos and Valenti (2002) also concluded that shrimp (*M. rosenbergii*) and tilapia polyculture did not affect fish production. In a 175-day assay, these authors obtained average production of 3445 kg/ha for tilapia monoculture and average production varying from 3671 to 3857 kg/ha for tilapia polyculture. Which similar in the present study, when compare between control as monoculture and (1RT:3FWP) and (1RT:4FWP) as polyculture, being; 29.35±0.34 in the former and 30.17±0.70 and 35.80±0.34 respectively in the latter. There were no significant differences for fish survival rates between different treatments. Tilapia final survival rate in monoculture (control) (90.00 ± 0.20a %) was similar to the survival rate observed in the polyculture systems 1RT:2FWP (90.00 ± 0.44%) and 1RT:3FWP (90.00 ± 0.21%). Fish average survival rates were similar to the results reported by García-Pérez *et al.* (2000) between 84 and 85% for tilapia *O. niloticus* at the following densities: 7 shrimps *(M. rosenbergii)* and 1 tilapia.m-2 and higher than the values reported by Santos & Valenti (2002), between 64 and 72% for tilapia-shrimp polyculture at densities of 2, 4 and 6 shrimps *(M. rosenbergii)* and 1 tilapia.m-2. The high survival rates obtained in the present study indicate that management was adequate and water physico-chemical parameters were within the ideal range for the cultivated species.

There were significant differences for final survival rate of prawn grown at different densities in polyculture systems. However, unlike the high survival rates observed for tilapia, shrimp survival rates were low (48.33 ± 0.12e % for 1RT:6FWP; 62.00 ± 0.33% for 1RT:5FWP; 65.00 ± 0.27% for 1RT:2FWP, 73.33 ± 0.60% for 1RT:3FWP and 80.00 ± 0.44% for 1RT:4FWP). Candido *et al* (2006) studied a *L. vannamei* and *O. niloticus* polyculture at densities of 2 tilapias.m-2 and 4, 8 and 12shrimps.m-2, and reported average shrimp survival rates of 83.3%, 88.5% and 86.1%, respectively. The high mortality rate in this study probably happened as result of prawn high density and minimize of cultivated scale. No statistical differences were observed for feed conversion rate (FCR) between mono as (2.82± 0.08 for 1:0) and polyculture systems as (2.58 ± 0.07 for 1:4) at ($p<0.05$). Average FCR was 1.08±0.48 /1, i.e., 1.08 g of feed was consumed to produce 1 kg of fish and prawn biomass. Santos and Valenti (2002), while studying tilapia and prawn *M. rosenbergii* polyculture reported significant differences for this variable: 1.94; 1.94 and 1.86 at the following densities 1 tilapia.m-2 and 2, 4 and 6 shrimps.m-2, respectively. Possibly, the high FCR of this study is due to differential between field and lab habits.

Conclusion

Different shrimp stocking densities did not influence total biomass gain of Nile tilapia. However, individual biomass gain of shrimp varied inversely with shrimp stocking density; therefore, shrimp biomass increased at lower stoking density from (1: 4, 5 and 6). The polyculture of red hybrid tilapia (*Oreochromis sp.*) and fresh water prawn *M. rosenbergii* in stoking density (1:3and4) proved to be technically feasible, since one species did not interfere with the development of the other, and from performance indicators, in comparison with monoculture.

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