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Effect of dietary protein level on the growth of Giant freshwater prawn (*Macrobrachium rosenbergii*) and tilapia (*Oreochromis niloticus*) under polyculture system in northern Bangladesh

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Abstract
The present experiment was conducted to assess the effects of dietary protein on the growth of Golda (*Macrobrachium rosenbergii*) and Nile Tilapia (*Oreochromis niloticus*) in ponds for a period of 4 months under three treatments of dietary protein levels viz. T_1: 20% protein level (commercial feed), T_2: 25% protein level (home made feed) and T_3: 30% Protein level (commercial feed) each with three replications. Prawn and tilapia were stocked @ 19760 individuals/ha and 4940 individuals/ha with mean initial stocking weight of 2.66±0.08g and 36.78±3.25g respectively. Water quality parameters (water temperature, transparency, pH, dissolved oxygen, NH_3-N and alkalinity) were monitored fortnightly and growth parameters were monitored monthly. Except transparency, treatments did not vary significantly for the mean water quality parameters. Significant differences were found for the growth parameters among the treatments except the mean weight gain (monthly) and the specific growth rate (SGR). Significantly highest yield was recorded from treatment T_3 where the fishes were fed with commercial feed having 30% protein level. Duncan's multiple range test showed significantly higher (p<0.05) specific growth rate (3.05% and 3.06%), survival rate (74.50% and 96%) in prawn and tilapia respectively fed with 30% protein rich feed (T_3).In calculation of economics, significantly higher total return, net benefit and cost benefit ratio (CBR) were also recorded with the treatment T_3. Better performances in production and economics with treatment T_3 indicates that prawn and tilapia farming fed with 30% protein rich feed is more profitable in pond condition of northern Bangladesh.

Keywords: Polyculture, *Macrobrachium rosenbergii*, *Oreochromis niloticus*, protein level and economics

1. Introduction
The Golda or the giant freshwater prawn (*Macrobrachium rosenbergii)* has attracted farmers as an aquaculture species in many parts of the tropical and sub-tropical countries throughout the world [19]. Due to favorable climatic condition and presence of good numbers of shallow water bodies suitable for prawn culture, the potentiality of prawn farming in Bangladesh is also well documented [2, 12, 16,17].

Despite the great potential of freshwater prawn farming in Bangladesh, successful commercial culture faces a number of constraints including high production costs, insufficient supply of post-larvae, poor quality of feed, water pollution, disease and food [3]. Protein is the main constituent of the fish body thus sufficient dietary supply is needed for optimum growth but it is the most expensive macronutrient in fish diet [20]. Cost of aquaculture feed, which is directly related to the protein content, appears to be the major limiting factor influencing the economic feasibility of aquatic animal farming. So, the amount of protein in the diet should be just enough for fish growth where the excess protein in fish diets may be wasteful and cause diets to be unnecessarily expensive [1]. Reducing feeding costs could be a key factor for successful development of aquaculture.

Prawn polyculture has a potentially higher net return than prawn monoculture [22], and thus with the Nile tilapia could be an important species to practice in rural ponds of Bangladesh. The both species also require similar temperatures to obtain high productivity and reach to commercial size within five months [21].

Accumulated knowledge of the nutrient requirements of the prawn is limited and there is lack of standard techniques among researchers in Bangladesh. But for raising the successful culture of any species; knowledge of its nutritional requirement is of prime importance. Rationalization of stocking density, species composition and supplementary feeding of prawn with carps and tilapia has been examined out by several researchers [4, 13, 16, 17, 23, 28] in northern part as well as other parts of the country. But no study has been carried out to evaluate the effect of different protein level on prawn-tilapia polyculture. Thus, the present work has been designed to evaluate effect of varying levels of protein on the growth and economics of mixed culture of *M. rosenbergii* and tilapia (*O. niloticus*) in pond condition of northern Bangladesh.

2. Materials and Methods

2.1 Time and study site

The study was conducted in nine experimental ponds of Fisheries Department under Rajshahi University for a period of 4 months (September 2010 to December 2010). The ponds were rectangular in shape with an average area of about 0.002 ha and average depth of one meter.

2.2 Experimental design:

The experiment was conducted in nine ponds with three treatments of dietary protein levels (T_1: 20% protein level (commercial feed); T_2: 25% protein level (home made feed: rice bran 35%, fish meal 25%, oil cake 25% and wheat flour 15% as binder) and T_3: 30% Protein level (factory feed) (Foysal Agro Fisheries Feed Limited- a local feed company) each with three replications.

2.3 Pond preparation, stocking and post-stocking management

Lime (Calcium Carbonate) was applied at the rate of 247kg/ha after removal of aquatic weeds and unwanted species. All the ponds were fertilized with cow dung (2470kg/ha,) Urea (50kg/ha,) and TSP (50kg/ha) 7 days before stocking as basal dose. Shelters in the form of branches of bamboo tree were also provided in the ponds for prawn before stocking. After one week of basal fertilization, all the ponds were stocked with tilapia fingerlings @ 4940 individuals/ha in the morning and prawn juveniles @ 19760 individuals/ha in the evening. The mean initial stocking weight of prawn and tilapia was 2.66g and 36.78g respectively. Supplementary feeds were provided in all ponds with the help of feeding trays. The supplementary feed was supplied for prawn at the rate of 5% body weight of prawn at the first 1 month and then gradually reduced to 4% at the 2nd month and 3% at the 3rd and 4th at the end of the trial. The feeding was provided twice daily to all the treatments. After stocking all the ponds were fertilized with cow dung (50kg/ha), Urea (1.25kg/ha) and TSP (1.25kg/ha) as daily basis.

2.4 Sampling

The physico-chemical parameters of water such as temperature, transparency, dissolve oxygen (DO), pH, NH3-N and alkalinity were recorded fortnightly (9.00 am to 10.00 am) by using water testing kit (HACH kit, FF-2, USA). Sampling for the growth performance of prawn and tilapia were done as a monthly basis. At least 10% of the stocked prawn and tilapia were caught from each pond for the study of growth performance. Length and weight of the sampled fishes and prawn were measured using scale and digital electronic balance (OHAUS, MODEL no.CT-1200-5). Weight gain was calculated by deducting the initial weight from the final weight and it was expressed as g. Final weight was taken at the time of harvest and was also expressed as g. Specific growth (SGR, bwd^{-1}) Cook *et al*. [9] was calculated as follows:

$[L_n \text{ (final weight)} - L_n \text{ (initial weight)}] / \text{culture period (day)} \times 100$

Survival rate was calculated on the basis of total number of fish and prawn during harvesting and it was expressed as percentage. Yield was calculated by deducting biomass at stock from biomass at harvest and it was expressed as kg/ha.

2.5 Analytical methods and statistical analysis

In case of protein analysis of homemade feed, Kjeldahl methods were used in laboratory. The proximate composition of the diet ingredients and experimental diets were analyzed according to AOAC [6]. All the collected data were analyzed statistically to show the results as mean value with standard error through ANOVA (Analysis of Variance) using the computer software SPSS (Statistical Package for Social Science; version 17). Significance was assigned at the 0.05% level. The mean values were also compared to see the significant difference through DMRT (Duncan Multiple Range Test) after Gomez and Gomez [11].

3. Results and Discussion

3.1 Water quality parameters

The variation in the mean values of physico-chemical characteristics of pond waters are given in table 01. Except water transparency no significant variation was for the other observed water quality parameters.

The mean water temperature varied from 27.10±0.07 (T_2) to 27.28±0.98° C (T_3). The finding is in the agreement with Hoq *et al*. [14] who reported that the water temperature ranged from 27.5 °C to 30 °C was suitable for growth of prawn. Ling [18] has reported that suitable range of temperature for prawn 22.0 °C to 32.0 °C.

Water transparency varied from 36.49±0.14 (T_1) to 38.13±0.14 (T_3) cm. This finding is more or less similar with the findings of Hossain and Akhteruzzaman [15]. Boyd [7] has recommended that transparency of about 30-45 cm indicates productivity of a water body. In the present study, the pH was found to be 7.59±0.04 (T_1) to 7.66±0.04 (T_2) which did not show any variation between treatments which concurs with Hossain and Islam [16] and Hossain and Kibria [17].

The mean value of dissolved oxygen of water varied from 3.60±0.28 mg/l (T_3) to 3.78±0.17 mg/l (T_1). Hossain and Akhteruzzaman [15] recorded dissolved oxygen ranging from 2.80 to 3.2mg/l for prawn-carps polyculture in pond condition of northern Bangladesh.

In the present study, ammonia-nitrogen was found to be ranged from 0.0229±0.0002 (T_2) to 0.0230±0.0004 (T_3) mg/l. Boyd [8] has suggested to keep the ammonia-nitrogen value in fish pond as less than 0.1 mg/l.

The mean value of total alkalinity was found to be ranged from 129.91±2.41 (T_2) to 132.81±1.31 (T_1) mg/l. Boyd [8] stated that the natural fertility of pond water increases with increase in total alkalinity up to at least 150 mg/l. Alikunhi [5] has suggested that total alkalinity more than 100 mg/l should be present in high productive water bodies.

Table 1: Variations in the mean values (±SE) of water quality parameters under different treatments during the study period

Parameters	Treatments		
	T_1	T_2	T_3
Water temperature (°C)	27.21±0.98[a]	27.10±0.97[a]	27.28±0.98[a]
Transparency (cm)	36.49±0.14[b]	37.89±0.16[a]	38.13±0.14[a]
pH	7.59±0.04[a]	7.66±0.04[a]	7.61±0.04[a]
DO (mg/l)	3.78±0.17[a]	3.73±0.25[a]	3.60±0.28[a]
NH_3-N (mg/l)	0.0232±0.0003[a]	0.0229±0.0002[a]	0.0230±0.0004[a]
Alkalinity (mg/l)	132.81±1.31[a]	129.91±2.41[a]	132.81±1.29[a]

Figures bearing common letter(s) in a row as superscript do not differ significantly (P<0.05)

3.2 Growth performance

The variations in the mean values of growth parameters of prawn and tilapia under different treatments are shown in table 02. The mean values of SGR (%) of prawn and tilapia varied from 2.86±0.68 (T_1) to 3.05±0.54% (T_3) and 2.71±0.64 (T_1) to 3.06±0.48% (T_3) respectively. No significant difference was found among the treatments for the SGR of prawn and tilapia. Hossain and Kibria [17] have reported the SGR of prawn ranged from 2.08 to 2.19% in overwinter polyculture of prawn and carps. Uddin *et al*. [27] have reported that the specific growth rate of tilapia as 2.47±0.05% polyculture with prawn using supplementary diets (crude protein 25%).

The mean values of final weight of prawn and tilapia varied significantly from 81.91±0.43 (T_1) to 110.81±1.55 g (T_3) and 278.18±2.02 (T_1) to 339.58±4.60 g (T_3) respectively. Hoq *et al* [14] have conducted a study on polyculture of *M. rosenbergii* with Indian major carps at a stocking density 13545 ha^{-1} and 2470 ha^{-1} for 6 months and observed that prawn grows to a final weight of 92.3 g. Garcia-Perez *et al*. [10] reported that the final weight of tilapia 331±38 g in polyculture with prawn.

The mean values of weight gain of prawn and tilapia varied from 19.81±5.54 (T_1) to 25.21±7.92 (T_3) and 20.28±5.61 (T_1) to 27.46±9.60 (T_3) respectively. Significant difference was found among the treatments for weight gain of prawn and tilapia. In case of prawn the mean values of weight gain more or less agreed with sidddique *et al*. [24] who reported weight gain of prawn ranging from 25.2 to 37.0 g at prawn density of 7500/ha. Another researcher, Uddin [27] has reported that the weight gain of prawn 16±2 to 20±3 g with and without substrate adding in culture pond.

During the present study, the survival rate of prawn varied significantly from 66.00±1.00 to 74.50±0.50%. The present finding is in agreement with the values reported by Hossain and Kibria [17] who reported the survival rate ranged from 70.0% to 76.3% for *M. rosenbergii* with carp in polyculture.

In case of tilapia, survival rate varied significantly from 74.50±0.50 to 93.00±1.00%. This survival rate was more or less similar to the survival rate 90.3±3.8% recorded by Tidwell *et al* [25] in pond polyculture system with prawn.

The benefit of any aquacultural venture is reflected through the ultimate production figure, which showed significant variation amongst the treatments. The yield of prawn nearly similar to the finding of Tidwell *et al*. [25] who reported a gross production of 1625 kg/ha in polyculture with tilapia fed a sinking pellet (28% protein) for 114 days. On the other hand, The yield of tilapia varied from 924.22 ± 6.55(T_1) to 1502 ± 6.31 kg/ha/4 months (T_3) which is in line with the finding of Uddin *et al* [26]. Combined yield significantly varied from 1969.50 ± 11.86(T_1) to 3098± 11.53 kg/ha/4 months (T_3). The results of the present study corroborate with the findings of Hossain and Akhteruzzaman [15] and Hossain and Islam [16] who have worked on polyculture of prawn and carps in Bangladesh. The result revealed that the overall growth performance of prawn and tilapia was found best with treatment T_3 (i.e. commercial feed with 30% protein).

Table 2: Variations in the mean values (±SE) of growth performances of prawn and tilapia under different treatments during the study period

Parameters	Treatments		
	T_1	T_2	T_3
Prawn			
Final weight	81.91±0.43[c]	99.39±1.79[b]	110.81±1.55[a]
Weight gain (g)	19.81±5.54[a]	24.19±7.08[a]	25.21±7.92[a]
SGR	02.86±0.68[a]	03.02±0.58[a]	03.05±0.54[a]
Survival rate (%)	66.00±1.00[b]	73.50±1.50[a]	74.50±0.50[a]
Yield (kg/ha/4months)	1041.00±1.31[c]	1454.00±31.25[b]	1597.70±3.46[a]
Yield (kg/ha/yr)	3139.10±1.21[c]	4280.70±12.53[b]	4785.10±3.11[a]
Tilapia			
Final weight	278.18±2.02[c]	305.76±0.78[b]	339.58±4.60[a]
Weight gain (g)	20.28±5.61[a]	24.51±7.26[a]	27.46±9.60[a]
SGR	2.71±0.64[a]	2.88±0.63[a]	3.06±0.48[a]
Survival rate (%)	80.00±0.50[b]	90.50±0.50[a]	96.00±1.00[a]
Yield (kg/ha/4months)	924.22±6.55[c]	1180.80±3.06[b]	1502.10±6.31[a]
Yield (kg/ha/yr)	2761.00±7.96[c]	3528.30±4.86[b]	4471.90±5.62[a]
Combined yield of prawn and Tilapia			
Combined Yield (kg/ha/4months)	1969.50±11.86[c]	2634.70±34.31[b]	3098.00±11.53[a]
Yield (kg/ha/yr)	5900.1±20.07[c]	7809±7.67[b]	9257.00±2.51[a]

Figures bearing common letter(s) in a row as superscript do not differ significantly (P<0.05)

4. Economic analysis

The variations in economics of different treatments of prawn and tilapia polyculture during the study period are shown in Table 03. Total cost, total return, benefit and cost benefit ratio (CBR) significantly varied with the treatments.

Table 3: Economics of prawn and tilapia under different treatments during the study period (4 months)

Items (BDT ha^{-1})		Treatments		
		T_1	T_2	T_3
Pond Preparation		5000±0.00 [a]	5000±0.00[a]	5000±0.00[a]
Seed	Prawn	118560±0.00 [a]	118560±0.00 [a]	118560±0.00 [a]
	Tilapia	24700±0.00 [a]	24700±0.00 [a]	24700±0.00 [a]
Lime		5368.79±0.00 a	5368.79±0.00 [a]	5368.79±0.00 [a]
Fertilizer	Cow dung	4576.42±0.00 [a]	4576.42±0.00 [a]	4576.42±0.00 [a]
	Urea	3402.425±0.00 [a]	3402.425±0.00 [a]	3402.425±0.00 [a]
	TSP	4655.95±0.00 [a]	4655.95±0.00 [a]	4655.95±0.00 [a]
Feed		2154.153±33.96 [c]	1852.407±7.04 [b]	2973.476±7.61 [a]
Harvesting cost		6000±0.00 [a]	6000±0.00 [a]	6000±0.00 [a]
Total cost		178417.733±33.96 [b]	178115.993±7.04 [c]	179237.063±7.61[a]
Total Income (Fish sale)		429043.55±312.63 [c]	586652.67±6164.01 [b]	660321.67±4280.18 [a]
Benefit		250625.817±333.89 [c]	408536.674±6771.05 [b]	481084.604±4284.28 [a]
CBR		1.40±0.002 [c]	2.29±0.034[b]	2.68±0.02 [a]

Figures bearing common letters as superscript in a row do not differ significantly (P<0.05)

* Currency is given in Bangladesh Taka, BDT (1USD=70 BDT).

Treatment T_3 was found to vary more significantly than that of others for the value of profit. On the other hand, CBR indicating that prawn and tilapia farming fed with 30% protein rich feed was more profitable than others. The CBR was higher than the finding of Shahin *et al*., [23] 2011. In conclusion, it can be stated that better performances in production and economics with treatment T_3 indicated that prawn and tilapia farming fed with 30% protein rich feed was more profitable than others in pond condition and may be practiced in Bangladesh aquaculture conditions for an optimum yielding crop in Tilapia -prawn polyculture system.

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