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Production and profitability of *Macrobrachium rosenbergii* (de Man) using over-wintered juveniles under polyculture system

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Abstract
Production performance and economic viability of over-wintered juveniles of freshwater prawn, *Macrobrachium rosenbergii*, with Indian major carps *Labeo rohita*, *Catla catla*, *Hypophthalmichthys molitrix*, and *Ctenopharyngodon idella* were examined in a pond polyculture system for a six-month period from January to June in four sites, namely; Fulpur, Tarakanda, Gafforgaon, and Nandail upazilla under the Mymensingh district of Bangladesh. Four upazillas (sub districts) were considered as treatments, having three ponds in each treatment as replications. The stocking density of *M. rosenbergii*, *L. rohita*, *C. catla*, *H. molitrix*, and *C. idella* was 40, 4, 4, 10, and 2 per decimal, respectively. Prawn and fish were fed with farm-made supplementary feed @ 3% body weight twice daily. The ponds were fertilized fortnightly with urea and TSP. The water quality parameters were within the optimum ranges, and suitable for prawn-carp polyculture. The ranges of survival rate of prawn and carps were higher in all treatments (78.33-95.56%) with no significant differences. The yield of prawn was considerably higher (638.38 kgha^{-1}) in Fulpur, followed by 629.66, 592.23, and 558.59 kgha^{-1} in Tarakanda, Gafforgaon, and Nandail, respectively, while that of carps was the significantly higher in Nandail upazilla (1917.49 kgha^{-1}). A simple economic analysis showed that total expenditure was Tk. 176886 ha^{-1}, gross income was Tk. 366 760 ha^{-1} with a benefit cost ratio of 2.07. The results of the study revealed the high potentiality and profitability of producing prawn using over-wintered juveniles of prawn with carps under a polyculture system in the northeast region of Bangladesh.

Keywords: Over-wintered, juvenile, polyculture, production, economics, *Macrobrachium rosenbergii*

1. Introduction
Bangladesh is endowed with vast freshwater resources that are not yet fully exploited, except for carp culture. To meet the demand for raw material required for export by processing industries, there is an urgent need to expand the production base. Considering the high export demand, the giant freshwater prawn, *Macrobrachium rosenbergii*, has immense potential for culture in Bangladesh and in many of the tropical and sub-tropical countries throughout the world [11]. Being a benthophagic omnivore, the prawn proved itself as a good candidate for polyculture [9], although it is sensitive to low dissolved oxygen and high-water temperature [4]. About one million hectares of impounded freshwater bodies of Bangladesh offer great potential for freshwater prawn culture [6]. Currently, freshwater prawn is cultured in about 50,000 ha areas, which can be expanded in many parts of the country. In 2006, the total prawn production from different sources in Bangladesh was 26,285 t with an average rate of 500 kg ha^{-1}. Moreover, Mymensingh region in Bangladesh is very famous for carp polyculture [12], at the same time which indicates huge potentiality of freshwater prawn polyculture. The production performance of over-wintering juveniles of mono as well as mixed sex tilapia has been in the northeastern region of Bangladesh and the result was promising in the context of production [3]. Inland freshwater prawn farming has been taking place only during the summer season, as farmers have to wait for new juveniles. Whereas, there is potentiality to use over-wintered juveniles, which are faster growing and fewer mortality, so that two crops can harvest in one year. Very little work has been done thus far on the production of prawn using over-wintered juveniles with carps in a polyculture system in Bangladesh. The present study was carried out in view of the above situations with an ultimate aim of estimating the yield and profitability of prawn using over-wintered juveniles under a polyculture system.

2. Materials and Methods

2.1 Study area and pond facilities

The experiment was carried out at Fulpur, Tarakanda, Gafforgaon, and Nandail upazilla under the Mymensingh district from January to June through a participatory approach. The sites were selected considering the potential of prawn polyculture with carps.

2.2 Experimental ponds

The experiment was conducted in 12 perennial farm ponds. The culture system was assigned to four treatments in four upazillas having three replications each.

2.3 Pond preparation

Unwanted fish were removed by netting followed by using rotenone @ 35 gdec.$^{-1}$. After three days of using rotenone, lime was applied @ 1 kgdec^{-1}. After three days of liming, the ponds were filled with deep tube-well water to maintain required water depth. After three days of watering, all the ponds were fertilized with cow dung, urea, and TSP @ 6 kgdec^{-1}, 100 gdec^{-1}, and 200 gdec^{-1}, respectively.

2.4 Juveniles and Fingerlings Stocking

The experimental ponds were stocked with uniform-sized, overwintered juveniles of *Macrobrachium rosenbergii* and fingerlings of *Labeo rohita*, *Catla catla*, *Hypophthalmichthys molitrix*, and *Ctenopharyngodon idella* for all treatments. The stocking density of *M. rosenbergii*, *L. rohita*, *C. catla*, *H. molitrix*, and *C. idella* was maintained in all the treatments at 40, 4, 4, 10, and 2 dec^{-1}, respectively.

2.5 Post stocking management

A similar feeding schedule was followed for all treatments. Supplementary feed containing 10% fishmeal, 40% rice bran, 20% wheat bran, and 30% mustard oil cake was provided. The feed was applied @ 3% body weight twice daily. The dead leaves were used as shelter for prawn during the moulting period. Feeding rates were adjusted fortnightly after sampling. Fertilization was done in 15-day intervals. After two months of stocking, lime was applied at a rate of 0.25 kg dec^{-1} for calcareous supplement.

2.6 Water quality monitoring

The water quality parameters such as water temperature, water transparency, depth, dissolved oxygen, and pH were recorded fortnightly between 8 and 10 a.m. All parameters were recorded using a commercial kit box (HACH FF-1, USA). Secchidisk was used to assess water transparency.

2.7 Production monitoring

The weight of prawn and carps were recorded fortnightly using a random sampling method. Weight was measured with a simple balance and gross production (kg ha^{-1}) was calculated by the following formula:

$$\text{Gross production (kg ha}^{-1}) = \frac{\text{Survival rate x Stocking density x Final weight (g)}}{1000}$$

2.8 Survival rate

The survival rate of the total stocked prawn and fish were calculated as total catch of fish at harvest divided by initial release of fish and converted to percentage.

2.9 Statistical Analysis

The results are presented here as mean± standard error. One-way analysis of variance (ANOVA) has been tested, and Tukey's honestly significance difference (HSD) process has been applied for comparing different treatments at the 95% confidence level.

3. Results and Discussion

3.1 Water quality parameters

All the water quality parameters were within the best range for aquaculture (Table 1). The transparency and pH were fluctuated in different treatments with significant variation (p<0.05), while temperature, water depth, and dissolved oxygen (DO) did not show significant variation among the treatments (Table 1).

Table 1: Mean and SD values of water quality parameters for each treatment with the same letter do not differ (Tukey's HSD test, p<0.05).

Parameters	Treatments				Best range
	Fulpur (T_1)	Tarakanda (T_2)	Gafforgoan (T_3)	Nandail (T_4)	
Temperature (ºC)	22.97±1.2a	22.95±1.25a	23.23±1.23a	23.24±1.23a	22-27 [14]
Transparency (cm)	33.17±0.8a	37.71±0.91b	35.75±0.98c	35.3±0.99c	25-35 [5]
Depth (m)	1.24±0.05a	1.18±0.05a	1.18±0.07a	1.05±0.04a	1-2.5 [5]
DO (mgl^{-1})	5.27±0.31a	5.25±0.35a	5.57±0.33a	5.37±0.41a	4.5-9.9 [7]
pH	7.65±0.16a	7.53±0.14a	8.07±0.09b	7.83±0.13a	6-9 [2]

3.2 Production of prawn and carps

The production of prawn and carps differed significantly throughout different treatments (Table 2). The total production of giant freshwater prawn in Fulpur, Tarakanda, Goffargaon, and Nandail was 638.38, 629.66, 592.23, and 558.59 kgha^{-1}, respectively, and finfish production was 1702.52, 1634.59, 1900.93, and 1917.49 kgha^{-1}, in that order. The significantly highest prawn production was found in Fulpur upazilla (638.38 kgha^{-1}) and the lowest was in Nandail upazilla (558.29 kgha^{-1}), while the total production of carps was the highest in Nandail upazilla (1917.49 kgha^{-1}) and lowest in Tarakanda (1634.59 kgha^{-1}). Mondal *et al.* (2005) [10] reported average prawn yields of 481.50, 433.50, 402.25, and 402.25 kgha^{-1} with the stocking density of 12,350 individual ha^{-1} in Faridpur, Meherpur, Kustia, and Magura district of Bangladesh, respectively; while fish (*L. rohita*, *C. catla*, *H. molitrix and Puntius gonionotus*) production was 2560.25, 2279.53, 2294.4, and 2350.6 kgha^{-1} from the stocking density of 1235, 1235, 2470, and 2470 fishha^{-1}, respectively. The prawn production in the present study was higher than the results obtained by Mondal *et al.* (2005) [10], whereas fish productions were lower. The difference in production might be due to regional variations as well as differences in stocking densities. In a eight-month period, Alam *et al.* (2001) [1] found prawn yields of 423±144, 548±178, and 662±243 kg ha^{-1} with stocking densities of 35,

50, and 65 individual dec^{-1}, respectively, while fish (*H. molitrix, C. catla, C. idella* and *Barbodes gonionotus)* production was 1,891±153, 1,844±162, and 1,887±186 kgha^{-1} from the stocking of 19 fish per decimal. The production rates of prawn and fish obtained by the present study are within the range of Alam *et al*. (2001) [1]. Hence, the production could double by farming the next crop season in the same year.

Table 2: Species-wise yield (kgha^{-1}) in different treatments.

Species	Fulpur (T_1)	Tarakanda (T_2)	Gafforgaon (T_3)	Nandail (T_4)
M. rosenbergii	638.38 ±1.79^a	629.66±11.09^a	592.23 ±10.11^b	558.59 ±7.12^b
L. rohita	218.22±3.29^a	204.25±3.59^b	227.82±4.07^c	220.95±5.72^a
Catla catla	220.65±2.61^a	198.86±4.65^b	238.96 ±5.95^c	232.8 ±1.67^c
H. molitrix	992.74±30.42^a	963.24±6.80^b	1081.35±65.06^c	1180.98±9.18^c
C. idella	270.91±8.43^a	268.24±6.10^b	284.84±0.62^a	282.77±6.50^a
Total carp	1702.52±44.75^a	1634.59±21.14^b	1900.93±20.02^c	1917.49±23.07^c

Values in the same raw with different superscripts are significantly different.

The mean survival rate (%) of prawn in treatments T_1, T_2, T_3, and T_4 was 80.33±0.33, 78.33±1.76, 81.67±0.33, and 79.67±1.85, respectively (Fig. 1). Huq and Islam (2003) [8] reported the survival rate of fishes (*Pangasius hypophthalmus, C. catla,* and *L. rohita*) as 95-97%, and 78% for *M. rosenbergii* in a polyculture system. The survival rate (78.33%) of prawn in treatment T_3 of the present study was similar to the above study. Siddique *et al*. (1999) [13] conducted an experiment for the polyculture of *M. rosenbergii* with Indian major carps in ponds where the survival rates of prawn ranged between 73.3 and 86.6%, which was similar to the range (78.33-81.67%) of the present study. Hoq & Islam (2003) [8] and Alam *et al*. (2001) [1] found the survival rate of prawn in polyculture with carps to be 75% and 66-70%, respectively, which is lower than the present study. The higher survival rate in this study indicates prawn and fish survival performance are also good in the winter and spring seasons. Moreover, higher survival rate might be due to different stocking density, water quality, climate, and better mana

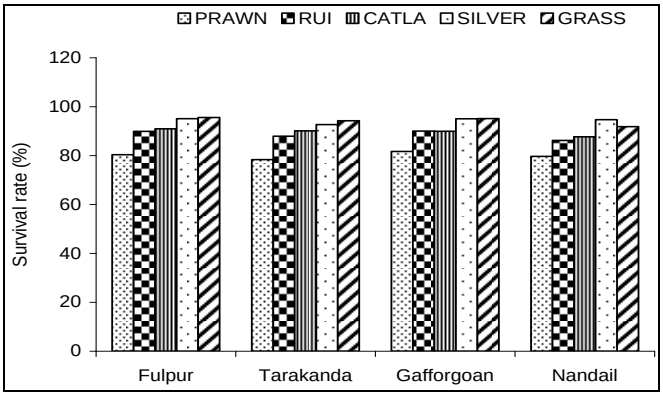

Fig 1: Survival rate (%) of prawn and fish in different treatments.

A simple economic analysis revealed that total expenditure was Tk. 176,886 ha^{-1}, gross income was Tk. 366,760 ha^{-1} and therefore, net income was Tk. 189,874 ha^{-1} with a benefit cost ratio of 2.07 (Table 3). Mondal *et al.* (2005) [10] reported that the average production cost of the prawn-fish polyculture was Tk. 120,310 ha^{-1} and the average gross income was Tk. 248,192 ha^{-1}, with an average net income of 1,27,882 ha^{-1}. The income level of the present study was more or less similar with the above study in terms of benefit-cost ratio.

4. Conclusion

The results of this experiment revealed that polyculture of over-wintered prawn with Indian major carps is feasible and it ascertains operators likely to have two crops in a year for boosting profit. Our findings also showed the culture of over-wintered prawn with carps in a polyculture system in the Mymensingh region is technically feasible and highly profitable. However, further research works are warranted with a view to develop the sustainable farming of prawn and carps under the polyculture system considering feeding the present and future human generations of the world.

Table 3: Cost benefit analysis in polyculture of prawn with carps. Bangladesh currency taka (BDT) is used here.

S. No.	Items	Total amount (No./kg)	Rate (BDT/kg or piece)	Total value (BDT)
A. Variable Cost				
1. Pond preparation				
a. Rotenone		8.5	250	2, 125
b. Netting		-	-	2, 000
c. Lime		247	10	2, 470
d. Urea		24.7	8	198
e. TSP		49.4	25	1, 235
f. Cow dung		1482	1.00	1,482
2. Fingerlings:				
a. Prawn		9880	6	59,280
b. Carps		4940	3	14,820
3. Feeds:				
a. Fish meal		350	50	17,500
b. Rice bran		1 400	10	14,000
c. Wheat bran		700	16	11,200
d. Mustard oil cake		1 050	25	26,250
4. Fertilizer (additional)				
a. Urea		271.7	8	2,174
b. TSP		534.4	25	13,585
5. Lime (additional)		123.5	10	1,235
6. Netting		-	-	2,000
7. Water supply		-	-	5,332
Total Cost of Production (A)				1,76,886
B. Income				
a. Prawn		604	400	2,41,600
b. Carp		1671.3	70	1,25,160
Gross income (B)				3,66,760
C. Net income (B-A)				1,89,874
BCR				2.07

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