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Effect of Feeds and Fertilizers on Growth and Survival Rate of Threatened *Labeo bata* Fry in Earthen Nursery Ponds

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Abstract: The present study was conducted to reveal the effects of formulated feeds and fertilizers on growth and production of the threatened fish *Labeo bata* (Hamilton, 1822) in nursery ponds of the Department of Fisheries, University of Rajshahi, Bangladesh for a period of 90 days from 11th July to 10th October, 2011. The experiment was designed with 3 treatments viz. Treatment 1 (T_1): formulated feed and fertilizer, Treatment 2 (T_2): only formulated feed, Treatment 3 (T_3): only fertilizer. The stocking density was same for all the treatments (500000 individuals/ha). Significant differences were observed in water transparency, CO_2 and alkalinity among the treatments. However, all the water quality parameters were within suitable range for optimal fish growth. The mean values of weight gain was found highest (6.46±0.16 g) in T_1 and lowest (5.40±0.14 g) in T_3, length gain was found highest (7.00±0.13 cm) in T_1 and lowest (5.50±0.12 cm) in T_3, specific growth rate (%) was found highest (6.86±0.03) in T_1 and lowest (5.98±0.2) in T_2, survival rate (%) was found highest (75.17±0.48) in T_1 and lowest (65.77±0.28) in T_3. The overall production and cost benefit ratio of *L. bata* fry rearing was significantly higher in T_1. The present study reveals that rearing of *L. bata* fry in nursery ponds is more profitable (Both in terms of growth and economics) while using both formulated feeds and fertilizers during culture period.

Key words: *Labeo bata* · Nursery · Feeds · Fertilizers · Growth · Survival Rate · Production · Cost Benefit Ratio

INTRODUCTION

Aquaculture is the fastest growing food sector and its economic significance is increasing concomitantly throughout the world [1]. Global aquaculture production increased 40 times since 1970 and is expected to quintuple in the upcoming 50 years [2]. Aquaculture provides healthy proteins for humans and complements the limited availability from overexploited fisheries [3-5]. In Bangladesh, during the period 1984/85 to 2008/09 aquaculture enjoyed an impressive growth rate of more than 9%. The contribution of aquaculture production in the national fish production increased steadily during the 1995-2004 and is estimated at 46.6% of the total fish production [6]. It is therefore clear, that if demand for fish is to be met in the coming years then aquaculture will certainly play a major role.

Labeo bata belongs to the family cyprinidae is an indigenous fish in Bangladesh, India, Myanmar but also reported from Pakistan and is introduced in Nepal [7]. The bata is highly preferred fish and is of high market value in Bangladesh [8-9]. But due to over exploitation, habitat loss and various ecological changes in its natural habitat; this species is on the verge of extinction [8-10].

Therefore, it is essential to take necessary steps to conserve and rehabilitate this fish from extinction. Under the present circumstances, pond culture of *L. bata* is a suitable option not only for increasing the fish production to meet the demand but also for the conservation of this threatened species. More importantly, *L. bata* automatically suits in the traditional carp polyculture system. However, the culture of *L. bata* needs constant supply of high quality fingerlings. In past, the main sources of fingerlings for aquaculture were

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principally the capture fishery and other natural water bodies as a result of limited capacity of the existing hatchery facilities to produce fish fingerlings [11]. Nonetheless, induced breeding techniques have continued to improve in Bangladesh and nowadays, hatchery produced fry/fingerlings are the main sources of seed for the aquaculture industry in the country. Yet development of appropriate nursing and rearing techniques of fry and fingerlings of *L. bata* is still not up to the mark. It is widely accepted that growth, survival and production of fry and fingerlings in nursery ponds depend on the appropriate application of fertilizers and formulated feeds. But very little information is available on the effects of formulated feeds and fertilizers on the growth and production of *L. bata* in Bangladesh. Subsequently, the present study was conducted with intention to reveal the effects of formulated feeds and fertilizers on the growth performance and production of *L. bata* fry in nursery ponds.

MATERIALS AND METHODS

Study Site: The present study was conducted over a period of 90 days from 11 July 2011 to 10 October 2011 in 9 earthen nursery ponds of the Department of Fisheries, University of Rajshahi, Bangladesh. The shape and surface area of each of the study ponds were rectangular and 1.0 decimal (0.004 ha), respectively with an average depth of 1.0 meter.

Experimental Design: A total of 9 study ponds were divided into 3 treatments (Treatment 1: T_1, Treatment 2: T_2 and Treatment 3: T_3) each with 3 replicates. In T_1, formulated feed (Fish meal 20%, rice bran 20%, wheat flour 30% and mustard oil cake 30%) and fertilizer (Cow dung, urea and TSP) were provided while in T_2, only formulated feed (Fish meal 20%, rice bran 20%, wheat flour 30% and mustard oil cake 30%) were provided and in T_3, only fertilizer (Cow dung, urea and TSP) were provided. Fry of *L. bata* was stocked at a rate of 500000 fry/ha in all the treatments. The formulated feed was given to the stocked fry at the rate of 10%, 8% and 5% of the total fish biomass in 1st, 2nd and 3rd month, respectively. Fertilization was done at weekly intervals at the rates of 435 kg/ha (Cow dung), 10 kg/ha (Urea) and 5 kg/ha (TSP).

Pond Preparation: The ponds were drained, freed from aquatic vegetation and well exposed to sunlight. After drying, quicklime (CaO) was spread over the pond bottom at a rate of 250 kg/ha to eradicate harmful insects and pathogens. Three days after liming, all the ponds were filled with ground water to a depth of about 1.0 meter. Then after 5 days, the T_1 and T_3 were fertilized by using cow dung at a rate of 1326.39 kg/ha, urea at 242.06 kg/ha and TSP at 192.66 kg/ha. Seven days after fertilization, dipterex (1.0 ppm) was sprayed to eradicate harmful insects. All the nursery ponds were surrounded by fine-meshed nylon nets fixed with locally available bamboo poles to protect the fish from escaping as well as to prevent predators (Such as frogs, snakes etc.) from entering the ponds.

Stocking of Fry: Fry of bata were collected from *Banga Bihary* Hatchery, Naogaon, Bangladesh. Before releasing the larvae to the experimental ponds the initial length and weight of 10% of the larvae were recorded with the help of a scale and a sensitive portable electric balance (OHAUS, MODEL no. CT-1200-5). Fish were released after conditioning.

Sampling: 10% of the stocked fry were sampled weekly by a fine-meshed nursery net for the assessment of growth (Length and weight), health condition and for feed adjustment. Water samples from each pond were collected during morning at 15 days interval for analysis of important physicochemical parameters such as temperature, transparency; dissolved oxygen, pH, total alkalinity and ammonia-nitrogen.

Study of Physicochemical Parameters: Secchi disc was used for the measurement of water transparency and water temperature was recorded using a Celsius thermometer (0ºC to 120ºC). Dissolved oxygen, CO_2, pH, total alkalinity and ammonia-nitrogen of water were measured by using a HACH Kit (DR/2010 model, HACH, Loveland, CO, USA, a direct reading spectrophotometer) at the study site.

Formula Used: The mean weight gain (g), mean length gain (g), specific growth rate (SGR %), survival rate (%) and production of the stocked *L. bata* were calculated using the following formula:

- Mean weight gain (g) = mean final weight - mean initial weight
- Mean length gain (cm) = mean final length - mean initial length

$$\text{SGR } (\%, \text{bwd}^{-1}) = \frac{Lnfinalweight - Lninitialweight}{Cultureperiod} \times 100$$

Statistical Analysis: All data were analyzed statistically using GraphPad Prism 5 statistical software (GraphPad Software, Inc. San Diego, CA) after they were checked for normal distribution and homogeneity of variance. Tests for normality of each group were conducted by visual assessment of histograms, box plots, homogeneity of variance and confirmed using the Kolmogorov-Smirnov test. Only percent data had to be arcsine transformed before analysis; however, non-transformed data are presented in tables. Where the normality assumption was met, a one-way ANOVA was used to examine treatment effects on weight gain, survival, growth and production. If the effects were significant, difference between the means was analyzed by a post-hoc (Tukey test) for unplanned multiple comparison of mean ($p<0.05$ level of significance).

RESULTS

Water Quality Parameters: The values (mean±SD) of water quality parameters over the 90 days nursery rearing of *L. bata* fry are presented in Table 1. The mean water temperatures in T_1, T_2 and T_3 were 31.93±0.09°C, 32.00±0.12°C and 31.95±0.09°C, respectively. No significant ($P<0.05$) differences in water temperatures were observed among the treatments. Mean water transparency differed significantly ($P<0.05$), increasing from T_1 to T_3. No significant ($P<0.05$) variations in the values of dissolved oxygen were observed among the treatments. Mean dissolved oxygen (DO) levels were higher in T_1 (5.52±0.06 mg/l) than those in T_2 (5.27±0.07 mg/l) and T_3 (5.35±0.08 mg/l). The mean value of CO_2 of water significantly varied from 2.18±0.04 mg/l (T_1) to 2.71±0.14 mg/l (T_3). The mean value of pH during the study period varied from 7.58±0.07 (T_3) to 7.76±0.09 (T_1). The pH value did not differ significantly ($P<0.05$) among the treatments. On the other hand, mean total alkalinity levels in T_1, T_2 and T_3 were 120.20±0.64 mg/l, 99.36±0.45 mg/l and 96.47±0.93 mg/l, respectively significantly decreased from T_1 to T_3. Moreover, mean ammonia-nitrogen levels were 0.12±0.01 mg/l, 0.15±0.03 mg/l and 0.13±0.02 mg/l in T_1, T_2 and T_3, respectively. No significant ($P<0.05$) differences were observed among the treatments.

Growth, Survival and Production of *L. Bata* Fry: Growth in terms of length and weight of fingerlings is shown in Table 2. The highest increase in length and weight was obtained in T_1 followed by T_2 and T_3. The growth indices, survival and production parameters recorded during this study are summarized in Table 2. No significant differences were observed in the initial length and weight of hatchlings stocked in all the experimental ponds. The mean final length and weight of fingerlings were significantly higher ($P<0.05$) in T_1 than those in T_2 and T_3. In addition, significantly higher weight and length gain were also observed in T_1 followed by T_2 and T_3. Specific growth rate was significantly higher ($P<0.05$) in T_1 followed by T_3 and T_2. Furthermore, the survival rate was also significantly higher in T_1 followed by T_2 and lowest in T_3 ($P<0.05$). Additionally, significantly higher amount of fingerlings was produced in T_1 (1902.79±2.46 kg/ha/90 days) than those in T_2 (1549.99±53.07 kg/ha/90 days) and T_3 (1301.02±22.27 kg/ha/90 days) (Table 2). However, total cost of production (Tk./ha) was consistently higher in T_1 (62400.00±0.55) than those in T_2 (58300.00±0.39) and T_3 (54650.00±0.62) though total benefit was higher in case of T_1 (Table 3 and Fig. 1).

Table 1: Variations in the mean values of water quality parameters of the earthen nursery ponds under different treatments during study period

Parameters	Treatments T_1	T_2	T_3
Water temperature (°C)	31.93±0.09^a	32.00±0.12^a	31.95±0.09^a
Transparency (cm)	22.97±0.09^c	31.85±0.08^b	34.77±0.28^a
DO (mg/l)	5.52±0.06^a	5.27±0.07^a	5.35±0.08^a
CO_2 (mg/l)	2.18±0.04^b	2.28±0.04^b	2.44±0.02^a
pH	7.76±0.09^a	7.73±0.04^a	7.58±0.07^a
Alkalinity (mg/l)	120.20±0.64^a	99.36±0.45^b	96.47±0.93^c
NH_3-N (mg/l)	0.12±0.01^a	0.15±0.03^a	0.13±0.02^a

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

Table 2: Variations in the mean values of fish growth parameters of endangered Labeo bata (Hamilton, 1822) in earthen nursery ponds under different treatments during study period.

Parameters	Treatments T_1	T_2	T_3
Mean initial weight (g)	0.41±0.03^a	0.41±0.03^a	0.41±0.03^a
Weight gain (g)	6.46±0.16^a	5.96±0.16^b	5.40±0.14^c
Final weight (g)	6.87±0.16^a	6.37±0.16^b	5.81±0.14^c
Mean initial length (cm)	1.12±0.05^a	1.12±0.05^a	1.12±0.05^a
Length gain (cm)	7.00±0.13^a	6.11±0.12^b	5.50±0.12^c
Final length (cm)	8.12±0.05^a	7.23±0.51^b	6.62±0.32^c
Percentage weight gain	1138.89±160.77^a	773.00±95.48^c	851.25±135.96^b
Percentage length gain	802.22±14.42^a	556.99±40.50^c	562.00±11.72^b
SGR (%, bwd^{-1})	6.86±0.03^a	5.98±0.2^c	6.59±0.02^b
Survival rate (%)	75.17±0.48^a	70.08±0.07^b	65.77±0.28^c
Yield (kg/ha/3 months)	1902.79±2.46^a	1549.99±53.07^b	1301.02±22.27^c

Figures in a same row having same superscript have no significant different (P<0.05)

Table 3: Variations in the mean values of different economical parameters under different treatments in earthen nursery ponds during study period.

Parameters	Treatments T_1	T_2	T_3
Pond liming and fertilizing (Tk./h[a])	24350 ± 0.00^{a}	24350 ± 0.00^{a}	24350 ± 0.00^{a}
Fry cost (Tk. /ha)	3850.00 ± 0.00^{a}	3850.00 ± 0.00^{a}	3850.00 ± 0.00^{a}
Feed cost (Tk. /ha)	29520.00 ± 15.25^{a}	25728.50±21.25b	22351.25 ± 31.25^{c}
Operational cost (Tk. /ha)	4680.00 ± 0.00^{a}	4372.50. $\pm0.00^{a}$	4098.75 ± 0.00^{a}
Total cost(Tk. /ha)	62400.00 ± 0.55^{a}	58300.00 ± 0.39^{b}	54650.00 ± 0.62^{c}
Fingerling sale(Tk. /ha)	43227.07 ± 0.15^{a}	35548.04 ± 0.25^{b}	26608.88 ± 0.12^{c}
Benefit(Tk. /ha)	19172.93 ± 0.32^{c}	22751.96 ± 0.12^{b}	28041.12 ± 0.25^{a}
Cost benefit ratio (CBR)	0.69 ± 0.05^{a}	0.61 ± 0.03^{b}	0.49 ± 0.05^{c}

Figures in a row bearing common letter(s) as superscript do not differ significantly ($p<0.05$); Leasing cost for pond is not included during this experiment and operational cost is considered as 7.5% of the total cost.

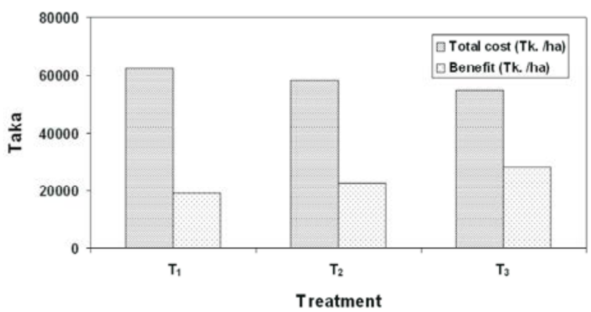

Fig. 1: Comparison of total cost and its benefits for the culture of endangered *Labeo bata* (Hamilton, 1822) in earthen nursery ponds under different treatments.

DISCUSSION

Though the water transparency varied significantly among the treatments, it was within the suitable range for supporting optimal fish growth in every case [12]. In addition, dissolved oxygen levels in all the experimental ponds recorded during the present study were suitable for fish culture [12]. However, all these findings were in lieu with the findings of Kohinoor *et al*. [13] and Rahman *et al*. [14]. On the other hand, all the chemical parameters (DO, pH, free CO_2 and ammonia-nitrogen) of the experimental ponds recorded during the present study were within the suitable range of good water quality for rearing of fry/fingerlings in nursery ponds [13-20].

The mean weight and length gain was found to be highest in treatment 1 (T_1) where both food and fertilization were provided followed by T_2 (Only formulated feed were provided) and T_3 (Only fertilization was done). These findings were in accordance with the findings of Akhteruzzaman and Kaiya [21]. Similarly, the mean values of final weight of *L. bata* were significantly higher in T_1 than that in T_2 and T_3. This outcome is akin to that of Alim *et al.* [22].

In addition, the SGR (%) was found to be highest in case of T_1 followed by T_2 and T_3. Findings clearly indicating better growth performance in *L. bata* fry rearing was found when both formulated feed and fertilizer were used rather than using only any of those. Likewise survival rate was also significantly higher in case of T_1. However, survival rate found in all the treatments in this study were more or less similar to that reported by Chakraborty and Mirza [23].

With no exception, significantly higher fish production was found in treatment T_1 during the study. Higher yield found in T_1 during this study could be due to providing higher percentage of protein through supplying formulated feed in combination with optimum fertilization in this treatment.

Analysis of cost-benefit ratio (CBR) revealed significantly higher CBR in case of T_1 (1:0.69) than T_2 (1:0.61) and T_3 (1:0.49). However, in all the treatments CBR were found in accordance to those reported by Grover *et al*. [24] and Azim & Wahab [25]

In conclusion, considering growth, survival and economic parameters, this study recommends the use of both feed and fertilizer during rearing of *L. bata* in nursery ponds.

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