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Effect of Stocking Density on the Growth and Survival Rate of Magur (*Clarias batrachus*) Fry in Laboratory and Nursery Ponds

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Abstract: An attempt was made to determine the effect of stocking densities on the growth of Magur (*Clarias batrachus*) fry (5.1±0.10 mg) for a period of 28 days in trays in laboratory. *Clarias batrachus* fry were stocked at the rate of 30, 40, 50 and 60 fry/tray i.e. 3, 4, 5 and 6 fry/litre of water. Stocking density of 30, 40, 50 and 60 fry/trays were designated as treatment I, II, III and IV respectively the fry was feed by grounded tubifex. The survival rate of *C batrachus* fry upto 28 days were found 92.3, 90.3, 89.3 and 80.1% at the stocking density of 30, 40, 50 and 60 fry/tray, respectively. The treatment had no significant effects on the ADG, SGR and weekly growth increment in length. Average daily gain of *Clarias batrachus* was found 20.80, 21.80, 19.46, 19.31 in treatment I, II, III and IV. The value of SGR (%) was 17.58, 18.68, 17.33 and 17.30% in the above treatments. The final cumulative gain in length were 39.50± 0.51, 39.90±0.10, 38.60±0.60 and 37.60±1.20 (mm) and fry reached to 588.3±33.29, 604.3±16.01, 550.0±25.00, 546.6±28.00 mg over a period of 28 days in treatment I, II, III and IV, respectively. The second experiment was performed to determine the effects of two selected feeds on the growth and survival rate *C. batrachus* fry in different nursery ponds for a period of 28 days. The protein level of the supplemental diet was 32.24% in feed I and 27.75% in feed II which were designated as treatment I and II. The feed was supplied daily at the rate of 10% of the body weight of the stocked *C. batrachus* fry. *C. batrachus* having an average initial length of 3.86±0.05 cm reached to the final length of 7.26±0.05, 7.12±0.02 and in the gain in body weight and 3.38±0.02 g under feeding treatment I and II, respectively. Analysis of variance (ANOVA) indicated that a significant difference ($p>0.05$) was observed in case of ADG, SGR, survival rate, cumulative growth increment in length and weight.

Key words: Stocking density, growth, survivas rate, nursery ponds

INTRODUCTION

In freshwater aquaculture, major culturable fish species of Bangladesh are Indian major carps, Chinese carps, common carps and tilapia. Little attention has been given in the culture of air breathing catfishes, live fishes like Magur (*Clarias batrachus*), koi, etc. which is about 20% of the total catch in Bangladesh[1] . The bulk of the catch of these fishes is based upon the collection from the wild population.

Among these live fishes, Magur is popular indigenous air breathing catfish. Generally deep ponds are required for carp culture, shallow and small ponds, ditches etc. can be used for culturing air-breathing catfish which could thrive in various adverse conditions. Sidthimunka and Ekura[2] observed that *Clarias* fry requires very shallow water level (2 to 3 ft), because at deeper water the could not swine to surface for gulping air and hence died. Magur (*C. batrachus)* is better suited to these shallow waters. In addition to their suitability for culture in derelict waters those catfish can also be cultured in proper well-managed shallow ponds.

Magur is omnivorous and bottom feeder in habit and breeds in nature during monsoon months in shallow waters usually after heavy shower when the adjoining areas of ponds and other depressions get inundated. This fish migrates to those areas and breeds there.

Clarias batrachus (L.) locally known as Magur in one of the most potential culturable species. It is very delicious and highly priced catfish. The popular belief is that there is a special nutritive and medicinal quality in this fish which is good for patients and convalescents by Mookerjee and Mazumder[3]. Still now, farmers have to depend on natural sources for collection of *C. batrachus* fry. Fry and fingerlings of the catfish are, however, difficult to obtain from natural waters for stocking the ponds. Many authors have studied the breeding biology of the fish successfully bred them artificially by using HCG and pituitary gland by Rahmatullah *et al.*[4], Islam *et al.*[5], Mollah and Karim[6], Naser *et al.*[7].

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Magur (*C. batrachus)* has slow growth despite all favorable qualities preferred by local people. An account of high nutritional value this fish is commonly eaten by people recovering from illness.

Want of feed in the appropriate size and quality is the main causes of high mortality and low growth at the early life stages of fry and fingerling. *C. batrachus* requires obligatorily natural live feeds during the early stage of life history and thus, for fry reating. The artificial feed is not recognized or not ingested because learning takes too long of feed particle size and density are incorrect by Huisman[8] and Vander Wing[9].

Rearing of *Clarias batrachus* fry with *Tubifex* sp. has been reported by Mollah and Nurullah[10]

The growth of fish is also dependent on the population density Bachiel and Le Cren[11]. Higher density may cause crowding effects and reduction in growth rate. So it is necessary to determine a suitable stocking density for fry rearing of *C. batrachus.*

Considering the importance of fry rearing, the present investigation was undertaken to study the growth and survival of Magur (*C. batrachus*) under different stocking densities feeding with different feeds.

The objectives of the study were to find out suitable stocking density for fry rearing of Magur (*C. batrachus*), fed on *Tubifex* in the laboratory condition and to study the suitability of two feeds for fry rearing of *C. batrachus* in the ponds.

MATERIALS AND METHODS

The research work was completed in two different stages. The first stage continued for 28 days to determine the effects of stocking density on the growth and survival rate of indigenous catfish, Magur (*Clarias batrachus*) fry under laboratory condition.

The second stage continued for 28 days to determine the effects of two different feeds on growth and survival rate of *Clarias batrachus* in nursery ponds.

Experiment 1: The experiment was conducted in the Laboratory of the Department of Aquaculture, Bangladesh Agricultural University, Mymensingh. For this experiment trys made of galvanised metal sheet 30.48x60.96x1.24 cm^3 in area were used in each tray 10 L of deep tubewell water was used as medium.

Trays were cleaned thoroughly and covered by the transparent polythene sheets. Water level in each tray was maintained 5.5 cm throughout the period of experiment.

The fry *C. batrachus* were obtained through induced breeding in the laboratory by injecting the male and female fish with Human Chorionic Gonadotropin (HCG).

The trays assigned to four treatment groups each having three replicates. Eight days old *C. batrachus* fry of initial total length of 9.10±0.10 mm and weight 5.1±0.10 mg were stocked at four stocking densities in treatment I, II, III and IV. The densities were 30, 40, 50 individuals/tray i.e. 3, 4, 5 and 6 fry/litre, respectively.

Live *Tubifex* were collected from the drains of Mymensingh. Live *Tubifex* were grounded by mortar and pastle and supplied in the tray, twice daily at 09.00 and 17.00 h to the fry. The left over food particles were removed 1 h after feeding by siphoning and the water level was adjusted up to the mark by fresh water.

Measurement of temperature dissolved oxygen and pH: During the study period, water temperature, measurement of temperature, dissolved oxygen and pH was recorded with a Celsius thermometer. Dissolved oxygen was measured by a portable dissolved oxygen meter (YSI Model. 58, USA). The pH of the water samples were measured with a portable pH meter (Jenway Model 3020).

Measurement of length and weight: Sampling was done weekly by the Scoop net and twenty fish were caught randomly from each tray and then length and weight of the individual fish were measured carefully. Weight was taken with a four figure digital balance (Mettler Toledo, PB 303) and the length with a measuring cm scale. Immediately after recording the length and weight the fry were released in the respective trays.

Survival rate: After 7 days fry in each tray were counted to find out the survival rate. The survival rate was calculated by counting the actual number of fish survived, divided by the initial number stocked and multiplying by 100.

Growth parameters: The growth of fry in length (mm) and in weight (mg) was measured every 7 days interval. The following parameters were used evaluate larval growth.

Average daily gain: The average daily gain was computed by subtracting the initial body weight from the final body weight and them divided by the number of days of rearing:

$$ADG = \frac{\text{Mean final weight} - \text{Mean initial weight}}{\text{Number of days}}$$

Specific Growth Rate (SGR%): The Specific Growth Rate (SGR) was determined by using the following formula:

$$SGR\ (\%) = \frac{LnW_2 - LbW_1}{t_2 - t_1} \times 100$$

Where:

W_2 = Final weight (g)
W_1 = Initial weight (g)
t_2-t_1= Time interval

Experiment 2: This experiment was conducted in the mini fish ponds situated on the northern side of Fisheries Faculty Building, Bangladesh Agricultural University, Mymensingh in order to find a suitable feed of *C. batrachus* fry. The experiment was undertaken over a period of 28 days. The area of each pond was 20 m^2. The ponds were rectangular in shape. The main source of water supply was underground water. The pond had inlet and outlet and the water depth was maintained at 1-1.25 m during the experimental period. The ponds were netted by a seine net to eliminate different kinds of fish and fully cleaned from harmful insects and weed fish by using Rotenone at the rate of 4 ppm as piscicide, after 7 days of poisoning, lime ($CaCO_3$) was mixed with water carefully and let it exposed for a while in a bid to avoid heat generation and finally sprinkled over the surface of the water in a soluble form at the rate of 200 kg ha^{-1}.

Pond fertilization: Ponds were fertilized with urea, Triple Super Phosphate (TSP) and cowdung at the rate of 40 and 5000 kg ha^{-1}, respectively 10 days before stocking the fry. The days after releasing fry cowdung was applied again in all the ponds at the rat of 2500 kg ha^{-1}.

Stocking of fry: The fry (36days old) from experiment-I were used in the ponds. over (average length and weight of fry were 3.02±0.01 cm and 0.28±0.01 g). Diet I is composed of Fish meal (50%)+ Wheat flour (25%)+ mustard oil cake (25%) and diet II is composed of Fish meal (50%)+Wheat barn (50%).

The fish were sampled weekly to measure their growth rates. During every sampling 10 fish from each pond were caught at random by seine net and their individual length and weight were measured and recorded properly. Length and weight gain, Specific Growth Rate (SGR) and average daily gain were determined similarly as mentioned in experiment I.

Statistical analysis: The experiment was laid down in Completely Randomized Design. Analysis of variance (ANOVA) and Duncan's New Multiple Range Test (DMRT) were performed to find out the effect of stocking densities on the growth and survival rate of *C. batrachus* fry, 5% level of significance.

RESULTS

Experiment 1

Rearing of fry in metallic trays: The value of pH ranged 8.0-8.9 in metallic trays where *Clarias batrachus* was kept. The mean value of pH was 8.4±0.27, 8.5±0.17, 8.25±0.3 and 8.5±0.26 in treatment I, II, III and VI, respectively (Table 1). Since the water supply was obtained from the same source, therefore no remarkable variation in the value of pH was observed among different trays.

The value of dissolved oxygen remained within 4.30 to 5.80 mg L^{-1} in metallic trays containing *Clarias batrachus* fry (Table 1).

The stocking density had significant effect on the survival rate of *C. batrachus* reared in the metallic trays (Table 2). Survival rate of *C. batrachus* was found to be 92.3±1.52, 90.3±1.52, 89.3±1.15 and 80.1±1.9% in treatments II, III and IV, respectively.

It is evident from Table 3 that the average daily gain in *C. batrachus* were 20.80, 21.40, 19.46 and 19.31 in treatments I, II, III and IV, respectively. While the SGR% were found to be 17.58, 17.68,17.33 and 17.30 for the above treatments. Analysis of Variance (ANOVA)

Table 1: Weekly variation of physico-chemical characteristics of water in metallic trays

Parameters	Treatments	1st week	2nd week	3rd week	4th week	Mean± SD
Temperature (°C)	I	28.30	27.95	28.60	28.5	28.33±0.28
	II	29.10	28.30	27.98	28.0	28.00±0.52
	III	28.80	28.50	29.20	28.8	28.80±0.28
	IV	28.60	28.80	28.50	28.7	28.60±0.12
pH	I	8.60	8.70	8.30	8.1	8.40±0.27
	II	8.80	8.50	8.40	8.5	8.50±0.17
	III	8.40	8.00	8.00	8.6	8.25±0.30
	IV	8.50	8.80	8.50	8.7	8.50±0.26
Dissolved oxygen (Do) (mg L^{-1})	I	5.20	5.40	4.80	5.1	5.10±0.25
	II	5.30	5.20	5.20	5.3	5.20±0.05
	III	5.30	4.60	5.60	4.3	4.70±0.61
	IV	5.60	5.80	5.00	5.4	5.40±0.34

Table 2: Weekly survival rate (%) of *C. batrachus* under different stocking density

Treatments	Stoking density (No./tray)	Cumulative growth in length (mm) 1st week	2nd week	3rd week	4th week
I	30	97.0±1.0	94.6±0.57	93.3±1.52	92.3±1.52[a]
II	40	96.0±2.64	91.0±2.64	91.0±1.73	90.3±1.52[a]
III	50	92.0±2.00	94.0±2.57	90.6±0.57	89.3±1.15[a]
IV	60	95.3±2.08	88.1±4.58	80.3±2.51	80.1±1.9[b]

Means followed by the same super scripts are not significantly different at 5% level of significance

Table 3: Average daily gain, Specific Growth Rate (SGR) in *C. batrachus* fry under different treatments

Treatments	Stoking density (No./tray)	Initial weight (mg)	Final weight (mg)	ADG	SGR (%)
I	30	5.1±0.10	588.3±13.00	20.80	17.58
II	40	5.1±0.10	604.3±16.00	21.40	17.68
III	50	5.1±0.10	550.0±25.00	19.46	17.33
IV	60	5.1±0.10	546.0±28.00	19.31	17.30

Table 4: Average cumulative growth of *C. batrachus* fry in terms of increase in length (mm) reared in the metallic trays

Treatments	Stoking density (No./tray)	Initial weight (mg)	Cumulative growth in length (mm) 1st week	2nd week	3rd week	4th week
I	30	9.10±0.10	17.10±0.20	26.00±0.25	30.80+0.25	39.50±0.51
II	40	9.10±0.10	17.20±0.40	25.90±0.30	30.70±1.10	69.90±0.10
III	50	9.10±0.10	16.90±0.10	25.80±0.50	30.00±1.00	38.60±0.60
IV	60	9.10±0.10	16.70±0.20	25.40±0.60	28.90±1.00	37.60±1.20

Table 5: Average cumulative growth of *C. batrachus* fry in terms of increase in weight (mg) in metallic trays

Treatments	Stoking density (No./tray)	Initial weight (mg)	Cumulative growth in length (mm) 1st week	2nd week	3rd week	4th week
I	30	5.1±0.10	41.30±0.64	158.0±2.0	291.8±7.90	588.3±33.29[b]
II	40	5.1±0.10	41.16±0.76	157.6±2.0	293.3±10.40	604.3±16.01[a]
III	50	5.1±0.10	39.00±1.00	154.6±5.0	289.0±10.58	550.0±25.00[a]
IV	60	5.1±0.10	38.16±1.60	152.3±2.5	282.0±4.30	546.6±28.00[a]

Means followed by the same super scripts are not significantly different at 5% level of significance

showed that there was no significant difference in the value of ADG and SGR in *C. batrachus* among different treatments. In other were SLl the treatments were similar in terms of average daily gain and specific growth rate (Table 3).

It is evident from that the growth increment in length of *C. batrachus* were more of less similar having no significant difference. ANOVA test revealed that all the treatments were alike i.e., there was no treatment effect on the length increment in *C. batrachus* (Table 4).

Table 5 shows that the starting from and initial weight of 5.1±0.10 mg. The *C. batrachus* fry reached to 588.3±33.29, 604.3±16.01, 550.00±25.00 and 546.6±28.00 mg in treatment I, II, III and IV, respectively (Table 5).

Statistical analysis indicated that the stocking density had significant effect on the cumulative growth increment of *C. batrachus* fry. Comparison of treatment means by DMRT test clearly demonstrated that treatment II (40 fish/try) gave followed by treatment I (30 fish/tray), treatment III and IV were not significantly different from each other i.e. both the treatment effects was similar.

Experiment II: The temperature of the earthen nursery ponds where *C. batrachus* was reared for 28 days were found to vary from 29.0 to 30.6°C. No appreciable change in the temperature reading was noticed among different ponds during the period of investigation (Table 6).

The secchi-disc visibility of the transparency of water was found 29.46±0.61 and 29.30±0.43 cm, respectively in treatment I and II (Table 6).

The hydrogen ion concentration (pH) was found 6.80±0.10 and 7.00±0.10, respectively in treatment I and II (Table 6).

The dissolved oxygen was found 4.63±0.35 and 4.13±0.41 mg L^{-1}, respectively in treatments I and II (Table 6).

Table 6: Physico-chemical characteristic of nursery ponds (Mean values±SD under different treatments

Parameters	Treatment I	Treatment II
Temperature (°C)	30.16±0.65	30.10±0.14
Transparency (cm)	29.46±0.61	29.30±0.43
pH	6.80±0.10	7.00±0.10
Dissolved oxygen (mg L^{-1})	4.63±0.35	4.13±0.41

Average daily gain and specific growth rate: The feeding treatments showed pronounced effect on the average daily gain and specific growth rate. The value of ADG 0.138 and 0.100 indicates that feed I was better than feed II (Table 7).

Cumulative growth rate: *C. batrachus* having an average initial length of 3.86±0.05 cm reached to the final length of 7.26±0.05 cm and in feeding conditions I and II, respectively (Table 8). There was no significant difference ($p>0.05$) in the gain is body length (cm) of *C. batrachus* between the two feeding treatments. On the other hand the feeding treatment exhibited significant differences ($p>0.05$) on attainment of body weight over a period of 4 weeks. *C. batrachus* grew to 4.45±0.04 and 3.38±0.02 g under feeding treatments I and II, showing that feeding treatment I had significant effect on gain in body weight (Table 8).

DISCUSSION

Experiment I: The physico-chemical characteristics of water in the metallic trays where the post-larvae of *C. batrachus* were reared did not show significant variation. Water temperature, dissolved oxygen, pH in the present study were found to be in the desirable range reported by Boyd[12], Jhingran and Pullin[13], Rahman *et al.*[14]. Therefore, no adverse effect of water quality parameter was evidenced on the existence *C. batrachus.*

Table 7: Average daily gain (g) specific growth rate (%) and survival rate (%) in *C. batrachus* under nursery pond condition

Treatment	Stoking rate	Initial weight (g)	Final weight (g)	ADG (g)	SGR (%)	Survival rate (%)
Feed I	15 m^{-2}	0.58±0.01	4.45±0.04	0.138^a	7.45^a	90^a
Feed II	15 m^{-2}	0.58±0.01	3.38±0.02	0.100^b	6.52^b	84^b

*Figures in column superscript with divergent letter are significantly different ($p<0.05$)

Table 8: Average cumulative growth in terms of increases in length (cm) under two feed in nursery ponds

		Cumulative growth in length (cm)			
Treatments	Initial length (cm)	1st week	2nd week	3rd week	4th week
Feed I	3.86±0.05	4.6±0.11	5.39±0.01	6.80±0.01	7.26±0.05a
Feed II	3.86±0.05	4.8±0.02	5.50±0.08	6.90±0.10	7.12±0.02b
		Cumulative growth in length (g)			
Treatments	Initial weight (g)	1st week	2nd week	3rd week	4th week
Feed I	0.58±0.01	0.96±0.03	159±0.01	2.83±0.05	$4.45±0.04^a$
Feed II	0.58±0.01	0.95±0.03	1.53±0.06	2.60±0.10	$3.38±0.02^b$

*Means followed by divergent super scripts are significantly different ($p<0.05$)

Stocking density is recognized as an important factor, which directly affect the growth, survival and production of fish by Bachiel and Le Cren[11]. Generally highest stocking density results in reduction of growth and survival and increase in the Food Conversion Ratio (FCR). and sever competition for food and space Powell[15].

It is a recognized fact that growth and survival of fish are negatively correlated with the stocking density provided that space-limiting effects operates on the population. According to Mollah[16] lower stocking density enhanced the survival rate of *C. macrocephalus* fry and promoted the larger size of the fish. The survival rate of *C. macrocephalus* larvae were higher upto a stocking density of 8 fish/litre of water as compared to those in 16 fish/litre[16]. These similar findings was also reported by Barua[17] in case of *C. batrachus* reduction in survival rate of *C. batrachus* was evidenced at a stocking density of 60 fry/tray i.e., 6 fry/litre of water. Barua[17] recommended stocking density 4 fish/litre. Haylor[18] demonstrated that larval age of catfish was significantly affected by initial stocking densities of 25-250 larvae/litre of water.

Das *et al.*[19] reported that the growth of waling catfish *Clarias batrachus* had inverse relationship with the stocking density and also suggested that 100 fry m^{-2} was best for rearing of *C. batrachus.*

However, no significant variation in the value of Average Daily Gain (ADG) and Specific Growth Rate (SGR) in *C. batrachus.* were observed at the stocking density of 30-60 fry/tray, I.e. 3-6 fry/litre of water. Similar findings regarding Average Daily Gain (ADG) and Specific Growth Rate (SGR) were noted by Barua[17].

Experiment II: The water temperature, pH. dissolved oxygen (mg L^{-1}) and secchi-disc depth (cm) were 29.1 to 30.6°C, 6.4 to 7.0., 7.0, 3.5 to 5.4, 27 to 35 cm, respectively in *C. batrachus.* ponds. Viveen *et al.*[20] also reported that the mean value of temperature, pH, dissolved oxygen and Secchi-disc depth for *Clarias culture* are 30.88°C, 8.34, 5.9 mg L^{-1} and 20.25 cm. Fry of *C. gariepinus* showed better growth at 30.C when compared with lower and higher temperature by Mollah and Hossain[21]. Considering the above findings, the water quality parameters were in favorable for fry rearing of *C. batrachus* in the experimental ponds.

The nutritive quality of feed stuff, its formulation procedure and mode of administration play a dominant role in the growth rate of fish. Two types of formulated feed which differed from each other in their proximate composition were evaluated on growth performance of *C. batrachus* feed 1 (32.24% protein) consisted of fish meal (50%), wheat flour (25%) and mustard oil cake (25%), while Feed II comprised of fish meal (50%) and wheat bran (50%).

The result of the feeding trial of *C. batrachus* indicated that feed I gave significantly better result. In another word, feed I was found to be better than feed II in respect of survivability of fish.

The value of ADG and SGR were higher in both species of fish supplied with feed I. Feed II gave significantly lower values of ADG and SGR. Therefore, considering the higher survival rate of fish, average daily gain and specific growth rate, it could be concluded that feed I was superior to feed II. Diet I was composed of three ingredients such as, fish meal (50%)+ mustard oil cake (25%), feed 1 contained both animal and plant protein which was presumed to be conducive to the growth and development of the fish. Feed II was in plant protein i.e. mustard oil cake. Wattanutchariya and Panayoton[22] reported that *Clarias* sp. are successfully grown on traditional diets consisting of fish meal, rice bran and broken rice having protein level of 25 to 38% no the dry diet basis. Chuapo Chuk[23] tested with 7 diets containing 20, 25, 30, 40, 45 and 50% protein and each diet

was used to feed 200 walking catfish (*Clarias batrachus*) fry kept in circular concrete tanks. Deyoe and Tiemeier[24] also found that when the amino acid levels were maintained the animal protein could largely be replaced by protein of vegetables origin. This result coincides with the findings of Ali[25] who conducted similar experiment on the rearing of the fry of catfish *Clatrias macrocephalus* by artificial feed. In his experiment fries were supplied with different supplemental feeds of 80-90% plant protein contained maximum amount of mustard oilcake, wheat bran and dried fish meal, the growth rate of fry was very low (125-150%) and mortality rate was very high on the other hand, fish suppkied with feeds combination of plant protein and animal protein showed satisfactory growth performance (250-445).

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