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GROWTH OF FRESHWATER MUD EEL (*Monopterus cuchia)* IN DIFFERENT WATER CONDITION, FEEDS AND PROBIOTICS

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Abstract

An experiment was conducted to study the effect of different feeds on growth and production of freshwater Mud Eel *(Monopterus cuchia)* in nine aquariums over a period of 90 days during June to August 2016. Three different feeds namely Feed A (live feed), Feed B (supplementary feed) and Feed C (probiotics) were applied to treatments I, II and III respectively. Three types of water used in aquarium. These are pond water, ground water and turbid water. Each of the tanks was stocked with nine fish that's total fish amount of 27. Significantly highest weight gain was obtained in pond water, treatment III, (16.39a ± 2.35). Treatment III yielded the highest (65.56a ±9.4 g/m^2 /year) production with the highest survival rate of fish. Water quality parameters like temperature, dissolved oxygen, P^H, and alkalinity were optimum. On the basis of better growth and production, it is suggested that pond water condition with probiotics are suitable for the culture of *M. cuchia* in aquarium.

Key words: *Monopterus cuchia*, feed, growth.

Introduction

The Gangetic mud eel (*Monopterus cuchia*) is a commercially important fish that is widely farmed in Bangladesh, northern and northeastern India, Pakistan, and Nepal (Jhingran and Talwar 1991). Commercial culture of freshwater mud eel, locally known as Cuchia, has been taken up after its successful breeding and nursing, which is a tasty fish and popular among ethnic people of our country Chakraborty *et al.* (2010). The freshwater mud eel is leading amphibious life and found in plenty commonly in stagnant waters in mud holes in shallow beels and boro-paddy fields with low oxygen content throughout the country of Bangladesh. The mud eel (*M. cuchia*) is a carnivorous and nocturnal prefers animal based food like small fishes, mollusks and worms, *etc*. This fish are recorded as rare species in Bangladeshi nature. Pollution from domestic, industrial and agrochemicals wastes and run off have resulted in extinction of a considerable amount of aquatic biota in same stretches of the open water system (Diaster 1990; Chakraborty and Nur 2009). An indigenous Cuchia weighs 50 to 2,000 grams. It is nutritionally rich and medicinally valuable fish with high export demands, which can play a unique role for socio-economic welfare of the area. However, the population of the freshwater eel is declining at an alarming rate from the natural water bodies due to several reasons, especially for overfishing while increasing the population of this fish completely depends on natural reproduction, and thus this fish are recorded as rare species in Bangladeshi habitats as well as Indian region (Das and De 2002). *M. cuchia* is more available in the fresh water of Bangladesh, Pakistan, Northern and North-East India and Nepal (Jhingran and Talwar, 1991). This fish is normally found in muddy ponds, swamps and rice fields and often spends the day hiding under crevices, water hyacinth, stones and mud. Cuchia is nocturnal as it comes out at night in search of food and may go into adjacent water bodies to feed. In nature, Cuchia feed on live small fishes, preferably stinging catfish, shrimp, and frog tadpoles. They eat more when they carry eggs. Over the years, research institutions, including Bangladesh Agricultural University (BAU) and Bangladesh Fisheries Research Institute (BFRI) have been working on breeding and commercial cultivation of this endangered fish. Freshwater eel culture is a low cost system compared to other small – scale fish culture does not necessarily require large water bodies and expensive formulated feed. The mud eel is quite hardy and pollution resistant. It can be profitably raised with aquatic crops like swamp cabbage (Nasar 1997). It often spends the day hiding under crevices, water hyacinth, stones and mud. It comes out at night in search of food and may go into adjacent water bodies to feed .The mud eel can serve as a predator against golden snails (which have become a pest) in some Asian countries particularly Philippines and Vietnam (Nasar, 1997). A little work has been reported on the growth, survival and production of this species. Few isolated studies related to haematology (Mishra *et al.*, 1977

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and Narejo*et al*. 2002), histochemistry of the unicellular gland (Mittal and Agrawal, 1977, Mittal *et al*. 1980) structure and histochemistry of epidermis and respiratory adaptations (Singh *et al.* 1989); rearing and production performance (Miah *et al.* 2015); effect of temperature on food, growth and survival rate during aestivation(Rahman *et al.* 2005); length-weight relationship and relative condition factor(Kurbah and Bhuyan, 2018); technical and co-management by ethnic *(Adivasi)* communities (Chakraborty *et al.* 2010); status and potentials studies of mud eel (Hossain *et al.* 2007); structure of the air-breathing organs (Munshi *et al.* 1989); morphometric study in West Bengal (Jana and Dasgupta, 2007); morphometric procedure were adopted from (Akter*et al*., 2016);fecundity and gonado somatic index (Chakraborty *et al*., 2013);marketing channel and export potentiality in Noakhali region, Bangladesh (Hasan *et al.*, 2012); reproductive biology, artificial propagation and larval rearing (Rahmatullah *et al*., 2000);current status and future research on south pacific eel (Pickering and Sasal, 2017);stress observation (Hangzo *et al*., 2016)reproductive cycle (Chakraborty, 2018) and eel catching gear (Barman *et al.*, 2013)are however available.The present study was under taken to examine suitable feed for commercial mud eel farming. This species has fishery value especially in India (West Bengal and Assam) where it is valued as a food fish (Talwar and Jhingran, 1991). People often rear *Monopteruscuchia*in cage and sell in local market (Hasan *et al.* 2012). It is cultured for food and medicinal value for anaemia. The habitat of this fish is freshwater and brackish water and found in shallow, well vegetated water and mud. They can live in holes without water by the help of respiratory organs. Some fishery scientist says that they pass entire summer in hole, but sometimes coming out from the hole to take oxygen. Most of the time in hole of water their mouth position is kept straight upper position and return into the hole completely when found any enemy. This fish can take feed day and night and can be easily cultured in a small tank, aquarium and other vessels while the species adjust well to life in captivity and are very hardy inhabitants. Though the effect of different feeds and shelters on growth, survival and production of freshwater *M. cuchia* in Bangladesh was studied. Dissemination of the eel culture, it is necessary to remove the impediment stated by Vaumik *et al*. (2017) availability of quality seed, lack of scientific and technical knowledge, lack of manpower, outbreak of fish diseases, lack of credit facilities, high price of various inputs, low fish price, theft of fish and poisoning the pond water. Considering the above circumstance, the present study was designed to attain the objectives, to know about growth of freshwater mud eel in different water condition and to know about growth of freshwater mud eel in different feeds and probiotics.

Materials and Methods

Study area

The experiment was carried out over a period of 90 days in laboratory aquarium, belonging to Department of Fisheries and Marine Bioscience, Jessore University of Science and Technology, Jessore, during the month of June to August 2016.

Preparation of aquarium

Twelve aquarium each of size 3 m, One was used for the stock. For convenience of study, the aquariums were numbered as 1, 2, 3, to 9. Water level in each aquarium was maintained 1.00 m throughout the experimental period by adding freshwater from pond water, ground water and turbid water. In each aquarium, given mud and rock just half meter below the surface for suitable environment. Every aquarium was surrounded black papers.

Collection of mud eel

Fishes of uniform size were obtained from local fishermen (Churamonkhati market).A total of 27 specimens were collected which age between 8 month to 12 month (Table 1).

Table 1. Initial fish weight and length of mud eel

No.	Initial body weight (g)	Initial body length (inch)	No.	Initial body weight (g)	Initial body length (inch)
01.	122.62	22	15.	97.89	21
02.	120.29	17	16.	103.45	18
03.	119.42	21	17.	105.31	21
04.	109.62	22	18.	102.54	20
05.	113.94	21	19.	119.44	19
06.	111.62	20	20.	117.61	21
07.	115.22	19	21.	121.54	22
08.	118.83	21	22.	82.79	17
09.	116.32	20	23.	85.23	19
10.	125.66	22	24.	84.34	20
11.	127.44	19	25.	118.37	19
12.	124.58	20	26.	115.56	20
13.	96.43	22	27.	117.45	21
14.	94.34	21	**Average**	**110.66**	**20.05**

Types of water

In this experiment, three types of water used in aquarium. These are pond water, ground water and turbid

water.

Supplied feed

Different types of feeds were given to the different environments for rearing and production of *M. cuchia*. Different types of feed such as small dead fish, small live fish (Tilapia fry), Supplementary feed, Probiotics were given. Feed were supplied to each of the different environment in different amounts. Every time feed were given at the morning at 10am and alternate food was supplied. Tilapia fry was used as feed and given weekly at the morning. The aquarium were divided in to three treatments namely I, II and III . Three different feeds namely Feed A, Feed Band Feed C were applied to the treatments I, II and III .Feed A was the live feed. Feed B was prepared with the combination of various Supplementary feed. Feed C was the probiotics (Table 2).

Table 2. Supplied feed category which used in this experiment

Live feed (Feed A, Treatment I)	**Supplementary feed (Feed B, Treatment II)**	**Probiotics (Feed C, Treatment III)**
Small dead feed	Mustard oil cake	*Bacillus sp.*
live feed (Tilapia fry)	Fish meal	*Bacillus coagulans*
	Rice bran	*Streptomyces*
	Wheat bran	

Sampling procedure

Each aquarium was provided with different food items like live small fish, dead small fish, pellet feed, probiotics and designated as treatment I, II and III respectively. Water depth was maintained at 1m for all aquariums. Ten fish of varied size (127.42 g) were reared in each aquarium and three replicates were maintained for each treatment. About 2/3 of the aquarium was covered with water hyacinth as shelter. Initially the feeds comprising of live small fish and dead small fish were supplied at the rate of 5% of the body weight, while 5.0 g of pellet feed was given twice daily at 11pm for one week. Sampling was done monthly. Water quality parameters like temperature, dissolved oxygen, pH, and alkalinity were recorded monthly throughout the study period. The pellet feed was made from locally available raw materials.

Growth performance

To growth performance of percentage weight gain (WG) Specific growth rate (SGR) and feed conversion ratio (FCR) were determined.

Weight (g) gain

Weight gain of the mud eel was calculated by the following formula –

Weight (g) gain (%) = $\{Final\ weight - Initial\ weight\} \times 100$

Specific growth rate

The specific growth rate of mud eel was calculated as –

SGR (%) = $\{Final\ weight\ (g) - Initial\ weight\ (g)\ /\ Time\ (days)\ \} \times 100$

Food conversion ratio

Feed conversion ratio was calculated by using the following formula –

FCR = Feed given (dry weight) / body weight × gain (wet weight)

Statistical analysis

To compare the significance of the findings, paired sample statistics for mean and standard deviation, paired sample correlations and paired sample significance test were calculated for the growth of experimental fish considering length and weight data from different environments. The statistical data was analyzed with Duncan's Multiple Range Test at 5% significance level by using Microsoft Excel Software.

Results

Different water quality parameters

In this experiment, physico-chemical parameters such as pH, dissolved oxygen, alkalinity, turbidity, NH_3-N and temperature for different rearing conditions were maintained and recorded Jun to August. The recorded pH from 7.30 to 7.48, temperature from 30-32℃, dissolved oxygen from 4.7-5.4 (mg/L), Alkalinity from 152-154 (mg/L), NH_3-N from 0.13-0.28 ppm, Turbidity from were observed in aquarium. The highest temperature was recorded in the turbid water and lowest was recorded with the ground water. The highest dissolved oxygen values were recorded pond water and lowest in turbid water.

Table 3. Water quality parameters from aquarium

Water types	**Parameters**					
	Temperature (˚C)	**p^H**	**DO (mg/L)**	**Alkalinity (mg/L)**	**Turbidity (NTU)**	**NH_3-N (ppm)**
Pond water	31.2	7.48	5.4	154	0.1	0.28
Ground water	30.4	7.30	4.9	152	0.07	0.13

Turbid water	32.1	7.42	4.7	154	0.2	0.19

pH of water was recorded highest in pond water and lowest in ground water. The values of alkalinity were highest in pond water and lowest in ground water. The highest NH_3-N was recorded in the pond water and lowest was recorded with the ground water.

Proximate composition of the different feeds

Different types of feed such as small dead fish, small live fish (Tilapia fry), Supplementary feed, Probiotics were given. Feed samples were analyzed to know the actual moisture, ash, crude lipid, protein, crude fiber, carbohydrate content (Table 4 and 5).

Table 4. Proximate composition analysis of the live feed

Feed types	Moisture (%)	Ash (%)	Crude lipid (%)	Protein (%)	Crude fiber (%)	NFE* (%)
Live small fish	32.10	15.40	9.30	20.30	0.70	22.20
Dead small fish	31.38	15.30	9.50	20.30	0.72	21.60

* Nitrogen free extract calculated as: 100- % (Moisture + Protein + Lipid + Ash + Crude fiber).

Table 5. Proximate composition analysis of the supplementary feed

Feed types	Moisture (%)	Crude protein (%)	Lipid (%)	Ash (%)	Crude fiber (%)	Carbohydrate (%)
Wheat bran	9.79	16.22	7.77	18.91	7.40	39.91
Rice bran	9.91	15.24	7.86	14.34	7.20	45.45
Mustard oil cake	17.46	29.81	9.80	7.08	3.30	32.55
Fish meal	8.89	39.18	7.50	11.16	3.17	30.10

Growth in different treatments reared in aquarium

Pond water condition

Firstly, these nine fishes (Table 1, 1-9 samples) were treated with pond water. Three different feeds were applied to the treatments I, II and III (Table 2) were used pond water. In this experiment, it has been shown that the highest weight gain (16.39a ± 2.35) in Treatment III which used in probiotics. The lowest final weight gain (7.66b ± 2.70) in Treatment II which used in supplementary feed (Table 6). The highest production was found in Treatment III .Conversely, the lowest growth performance Treatment II in pond water condition. There were no contamination of water and diseases were found during the study. The weight gain was observed in all treatments from June to August.

Table 6. Growth and production of *M. cuchia* in different treatments in pond water

Parameters	Treatment I	Treatment II	Treatment III
Initial weight	120.78a ± 1.65	111.73b ± 2.16	116.79a ± 1.85
Final weight	131.86a ± 2.05	119.39b ± 2.70	133.18a ± 2.35
Weight gain	11.08a ± 2.05	7.66b ± 2.70	16.39a ± 2.35
% Weight gain	9.17a ± 1.69	6.85b ± 2.41	14.03a ± 2.01
Production (g/m^2 /year)	44.32a± 8.2	30.64b ± 10.8	65.56a ±9.4

1. Figure in the same row having the same superscripts are not significantly different (p>0.05). Figures having different superscript are different significantly.
2. Standard deviation.

Ground water condition

These nine fishes (Table 1, 10-18 samples) were treated with ground water. Three different feeds namely Feed A, Feed B and Feed C were applied to the treatments I, II and III (Table 2) were used ground water.It has been shown that the highest weight gain (13.14b ±1.66) in Treatment III which used in probiotics. The lowest final weight gain (8.12c ±1.77) in Treatment II which used in supplementary feed (Table 7). The highest production was found in Treatment III. Conversely, the lowest growth performance Treatment II in pond water condition. The weight gain was observed in all treatments from June to August.

Table 7. Growth and production of M. cuchia in different treatments in ground water

Parameters	Treatment I	Treatment II	Treatment III
Initial weight	125.89a ± 1.44	96.22c ± 1.78	103.77b ± 1.41
Final weight	136.00a ± 1.40	104.34c ± 1.77	116.91b ± 1.66
Weight gain	10.11a ± 1.40	8.12c ± 1.77	13.14b ± 1.66
% Weight gain	8.03a ± 1.11	8.43c ± 1.83	12.66b ± 1.59
Production (g/m^2 /year)	40.44a ± 5.6	32.48c ± 7.08	52.56b ± 6.64

1. Figure in the same row having the same superscripts are not significantly different (p>0.05). Figures having different superscript are different significantly.

2. Standard deviation.

Turbid water condition

In this experiment these nine fishes (Table 1,19-27 samples) were treated with turbid water. Three different feeds namely Feed A, Feed B and Feed C were applied to the treatments I, II and III (Table 2) were used turbid water. The highest weight gain (16.19a ±2.18) in Treatment III which used in probiotics. The lowest final weight gain (10.53b ±1.93) in Treatment II which used in supplementary feed.The highest weight gain (16.19a ±2.18) in Treatment III which used in probiotics. The lowest final weight gain (10.53b ±1.93) in Treatment II where supplementary feed was used (Table 8 and Figure 3).

Table 8. Growth and production of *M. cuchia* in different treatments in turbid water

Parameters	Treatment I	Treatment II	Treatment III
Initial weight	119.53a ± 1.96	84.12b ± 1.23	117.13a ± 1.43
Final weight	131.58a ± 2.07	94.65b ± 1.93	133.32a ± 2.18
Weight gain	12.05a ± 2.07	10.53b ± 1.93	16.19a ± 2.18
% Weight gain	10.03a ± 1.73	12.51b ± 2.29	13.82a ± 1.86
Production (g/m^2 /year)	48.2a ± 8.28	42.12b ± 9.16	64.76a ± 8.72

1. Figure in the same row having the same superscripts are not significantly different (p>0.05). Figures having different superscript are different significantly.
2. Standard deviation.

Comparison of growth in different water condition and treatments

In this experiment, three types of water used in aquarium. These are pond water, ground water and turbid water. Based on Paired Sample Statistics, it has been shown that, pond water condition where the highest weight gain (16.39a ± 2.35) in Treatment III which used in probiotics. In the ground water condition, where the highest weight gain (13.14b ±1.66) in Treatment III which used in probiotics. In the turbid water condition, where the highest weight gain (16.19a ±2.18) in Treatment III which used in probiotics (Figure 1).Descriptive statistics gives an indication that pond water condition (Treatment III) gives more mean value in gain weight. In case of Pond water (Treatment III) mean values were highest so it may be suggested to implement with Pond water (Treatment III) getting best production. Growth performance of experimental fishes collected from all different environments showed satisfactory results. The weight gain was observed in all treatments from June to August.

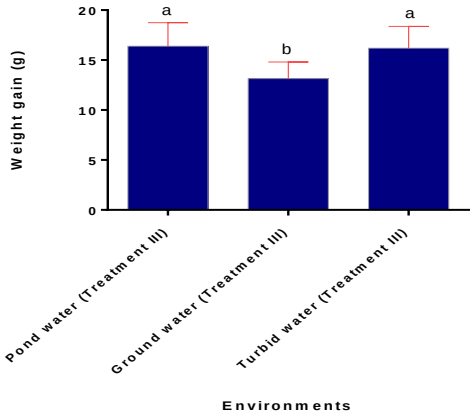

Figure 1. Mean growth of *M.cuchia* in terms of weight gain (g) fed with different feeds in different water condition

Discussions

The present study was conducted to determine the suitable environment for the best rearing and production performance of freshwater mud eel, *M. cuchia.* Considering different environments such as pond water, ground water and turbid water in aquarium. There are some factors which affect the growth and existence of any species such as water flow, light, temperature, concentration of nutrients, oxygen, carbon dioxide, ammonia, dissolved salt, PH and substrates like fine particles, autumn shed leaves, submerged wood and moss (Islam *et al.*, 2017a). In an another study Islam *et al.* (2017b) revealed that, factors to be considered include pond management, water quality and temperature, disease control, food supply, brood stock age, density and sex ratios. In the present study, Temperature, 30.4-32.1 ˚C; p^H, 7.30-7.48; DO, 4.7-5.4 mg/L; Alkalinity, 0.07-0.2 mg/L and NH_3-N, 0.13-0.28 ppm were found. The culture is varied from May to August depending on heavy rainfall, favorable temperature (Sharif and Asif, 2015). Shajib*et al.* (2017) stated, temperature 24.75 to 27.75 oC, dissolved oxygen 3.68 to 4.09 mg/L, pH 7.3 to 8.16, ammonia 0.3 to 1 mg/L, nitrite 0.01 to 0.03 mg/L, phosphate 0.6 to 1 mg/L and alkalinity 119 to 187 mg/L. The Temperature fluctuates 11° to 37° (Asif *et al.*, 2014). In on other study Zafar *et al.* (2017) found the water temperature of the treatments varied from 26.0 ºC to 31.5 ºC. Shabuj*et al.* (2016) revealed, the water quality parameters; temperature, pH, dissolved oxygen and transparency were recorded from 25-300c, 7-8.5, 4.5-7.1 ppm and 23- 31 cm in the brood rearing ponds

respectively.The range of pH, DO, transparency and temperature are 6-8, 3.5-5.25, 17-25 cm and 24-31°C (Hossain *et al*., 2016) . The temperature, pH, dissolved oxygen and transparency ranged from 22-34 0C, 6-8.5, 5-7.5 ppm and 22- 32cm of the water of brood rearing ponds (Ali *et al*., 2016b). The temperature of water was recorded between 26 to 31^{0}C during experimentation Ali *et al*. (2016c). Above all discussion this study is favorable with the previous study and majority of results is similar with the previous one. For better growth and development optimum temperature is a key factor. In this study, increasing weight gain was found during June to August, 2016 with optimum water temperature was (30.4-32.1℃), suitable for freshwater eel, *M. cuchia* and similar result was found by Narejo*et al.* (2002). Nasar (1997) reported an ideal temperature of 20-35℃ for proper feeding and growth of M. cuchia. Hossain *et al*. (2015) and Rahaman*et al*. (2015) stated that, tilapia can be used as feed for the growth of any kind of carnivorous fish. Growth performance was recorded highest in pond water (treatment III) condition in terms of weight gain in weight (16.39a ± 2.35). Conversely, growth performance in terms of weight gain in weight (7.66b ± 2.70) was lowest in pond water (treatment II). The supplied feed in pond water (treatment III), were probiotics. Besides, in pond water (treatment II), supplementary feed were supplied. The production performance in the present study was quite satisfactory after three months observation. The second highest growth performance in terms of weight gain was in turbid water (treatment III), in weight (16.19a ±2.18). Whereas supplied feed were given probiotics. Although, different environmental conditions were different amount of feed has different impacts on growth performance of fishes from treatment I, II and III. In the present study, it was observed that the probiotics were the best among all other supplied foods for better growth performance of freshwater mud eel, *M. cuchia*. As soon as the feed were supplied they engulfed it quickly. Ali *et al.* (2016a); Rahman *et al*. (2015); Shajib*et al*. (2017); Zafar *et al*. (2017); Shabuj *et al*. (2016); Hossain *et al*. (2016); Zaman *et al*. (2017); Haq *et al*. (2017) had conducted similar studies on different fish species and found more or less similar growth rate were performed in different circumstances. Rahman *et al*. (2015) found similar proximate composition which is strongly support this present study. There were no contamination of water and diseases were found during the study which is the directly against the study of Chowdhury*et al.* (2015); Shabuj *et al.* (2016); Yeasmin *et al*. (2016); Rahman *et al.*(2017) and Neowajh *et al.* (2017). Narejo*et al.* (2002) reported that this fish which were culture cemented cisterns with dead fish and found well growth, however, this study completely disagrees with some previous findings in freshwater mud eel as well as other eel fish while this study found that probiotics with earth worms and small live fish (Tilapia fry) were effective for better growth performance of *M. cuchia*. On the other hand, this findings with mostly related with findings of Chakrabarty*et al.* (2010) considering the same types of foods use. The survival rate of fish fed with small live fish (Tilapia fry), and small dead fish ranged from 75% to 92.5% while highest survival rate was in treatment I and lowest in treatment II. The total production of fish ranged from 30.64 to 65.56g/m2/year per year by 3 months of this experiment where Narejo*et al*. (2002) found the total production of fish ranged from 0.241 to 0.624 kg/m2/year. In case of pond water (treatment III), survival rate, growth performance and production were higher than the other environments. This natural environment allows mud eel to mature better than the others. It is clear from the present study that mud eel, *M. cuchia*could be reared successfully with probiotics in pond water condition with better growth rate and production.

Conclusions

Comparing different culture regimes aquarium, earthen ditches is the best one for proper maintaining and rearing of *M. cuchia* in terms of yield and profits. Though, aquarium or tank systems were found more productive with probiotics than others, however, to build up aquarium or tanks and to buy live feed and probiotics may cost effective for rural people which may not be economically feasible to them, rather aquarium, tank and earthen ditch will be prepared surrounding the house and maintain of culture will be very easier. Promoting social awareness about the nutritive value and export demand of this fish among the rural people can be encouraged to involve in culturing mud eel as an alternative livelihood. This can be a profitable sector for those involved in fisheries as it requires less capital.

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