Cat fish, *Clarias batrachus* rearing in mini- earthen ponds with various formulated feeds

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Cat fish, *Clarias batrachus* rearing in mini- earthen ponds with various formulated feeds

A Thesis

By

Mridul Kanti Ghosh

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In

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Cat fish, *Clarias batrachus* rearing in mini earthen ponds with various formulated feeds

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DECLARATION

The results submitted in this thesis are entirely of the candidate's own investigations and no part of the results has been accepted for any degree, nor is it being concurrently submitted for any degree

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Abstract:

An experiment was conducted in mini earthen ponds (1 decimal) for a period of seven months to explore the suitable laboratory prepared diet for *Clarias batrachus* fingerlings in terms of growth and survival. Seven weeks old fingerlings each having an initial weight of 2.89±0 g were reared in ponds at a stocking density of 500 individual/ 40m^2 pond. There were four treatments, each consisting of two replications. In three treatments, different formulated diets were used depending on source of protein supply viz. blood meal (T_1), fishmeal (T_2) and combination of blood meal and fishmeal (T_3) the other treatment had no feed (T_4). The ration of protein in each experimental diet was adjusted at 45%. The highest (80.54±2.65g) and lowest growth (7.39 ±0.72g) was found in T_2 and T_4, respectively. The survival rate of T_1, T_2, T_3 and T_4 was 58.2 ±3.49, 65.4 ±3.06, 62.6 ±2.66 and 21.6 ±1.73% respectively. There were no significant differences ($P>0.05$) among the survival rates of T_1, T_2 and T_3 while the significant difference ($P<0.05$) was present among treatments with various feed applications. The FCR of the three treatments were 2.44±0.55, 2.76±0.20 and 2.64 ±0.09 in T_1, T_2 and T_3, respectively. The total expenditure of T_1, T_2, T_3 and T_4 were 2946, 3759, 3492 and 1686 Tk/dm, respectively while the gross income of T_1, T_2, T_3 and T_4 were 3388, 5134, 4310 and 25 Tk/dm, respectively. The highest net income (1375 Tk/dm) came from T_2 and the highest return on investment (36.58%) also found in T_2. From the experiment it could be summarized that *C. batrachus* culture needs high proteinous supplementary feed and maximum output in terms of growth, survival and production was found when the formulated feed was prepared with fishmeal.

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Introduction

Bangladesh is ranked third largest in aquatic biodiversity in Asia behind China and India with approximately three hundred species of fresh and brackish water fish species (Hossain and Mazid, 2001). This species diversity has been attributed to one of the worlds' largest wet land (Bengal Delta) and three large river system that flow from the Himalayan Mountains into the Bay of Bengal. In addition, the country has vast inland water resources in the form of rivers, canals, estuaries, floodplains, depression (beels), ox-bow lakes, reservoirs, ponds and shrimp farms in coastal and marine areas with high potential of fish production.

Natural population of fish is rapidly decreasing due to lack of scientific management and draining out beels, marshes and similar natural habitat for meeting up the excessive market demand and also for the production of paddy and other agricultural crops. Breeding grounds of these species are in under threating due to indiscriminate use of fertilizers, insecticides and pesticides. Paucity of fry/fingerlings, unavailability of low cost artificial diets and determination of appropriate stocking density are still the major setback for fish farming commercially. Catfish, *Clarias batrachus* is no exceptional. Until recently, the supply of its fry comes from natural sources, which is one of the limiting factors towards catfish farming. Now we have been able to successfully obtain fry through artificial means, lack of suitable diets and larval rearing techniques at present is a significant problem for the acceleration of catfish production in the country.

Among freshwater fishes, catfishes are important as food fish in Asia and Africa. Asian catfish (*C. batrachus*), commonly known, as 'Magur' is one of the most preferred fish in Bangladesh. The major culturable fish species in Bangladesh are mainly the major and minor carps. Live fishes like magur, shingi, koi etc. accounted for about 20% of the total catch in Bangladesh (Uddin *et al.*, 2001). Catfish, *C. batrachus* is one of the most popular food fish among catfish species and is widely distributed all of the Bangladesh in rives, haors, baors, beels, jheels, canals and ponds and even in derelict ponds and swampy areas

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(CIFRI, 1985). In our country *C. batrachus* is not widely cultured due to non-availability of fry and lack of appropriate culture techniques.

Naser *et al.* (1991) reported that *C. batrachus* is preferred choice of Bangladesh people because of its taste and no contra muscular bones and high nutritive value. While Rahman *et al.* (2003) stated that *C. batrachus* contains considerable amount of protein and low lipid level. Again, according to Uddin *et al.* (2001), *C. batrachus* is fast growing due to omnivorous and scavenging feeding habits. Market access in live condition and fresh for long time, so it also known as geol fish, bears accessory respiratory organ that can be easily transported to long distance, tolerate and thrive in wide range of environmental fluctuation.

C. batrachus is a suitable species for semi-intensive to intensive culture because it grows in haors, baors, paddy fields and exhibits remarkable growth performance with in short time even in wastewater (Saha *et al.* 1998a). In Asia this fish is found in India, Pakistan, Thailand, Malaysia and Bangladesh (Nurullah *et al.* 1989). It spawns in both open and confined waters (Nurullah *et al.* 1989). It attains marketable size within six months while many other commercially important fishes are unable to reach market shortly. It was stated that *C. batrachus* could self-stand or replace common carp in integrated fish culture practices (Dehadrai *et al.* 1985). Besides, in the market it has good value considering nutrition, keeping quality, freshness, and their availability (Alam *et al.* 1995).

Very recently, probably the first time in Bangladesh, Hussain *et al.* (2001) conducted a comprehensive study on *C. batrachus* fingerlings in a growout pond with different operation systems, including mini earthen ponds, net cages, and cement cistern. They recommended that the total production *C. batrachus* in mini earthen ponds performed better than those of other two systems (net cages, and cement cistern), when the stocking density was 200 individuals/m^2. Protein source of the experimental fish was the solely fish meal which is considerably high price for farmers' conditions.

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Lack of larval rearing and their subsequent development in grow out ponds is still infancy which withholds the widespread culture commercially. Although numerous research on larval rearing with live and formulated diets have been conducted (Yasmin *et al.* 1998, Latif *et al.* 1998, Saha *et al.* 1998 a, Saha *et al.* 1998 b, Alam and Mollah, 1989, Mollah and Nurullah, 1988), no perfectly suitable larval diet under pond condition (grow out pond) has yet been developed that will be representative, requiring low cost and easy available. So, there is need to explore suitable larval feed of *C. batrachus* not only for commercial use but also the restoration of this species in nature. Therefore, an experiment was conducted with the aim of finding a suitable diet for successful rearing of *C. batrachus* larvae using locally available low cost feed ingredients.

Objective

The main purpose of this study is to find best possible diet for producing *C. batrachus* fingerlings in mini earthen ponds and culture them up to market size. It is not only for the conservation of their gene pool and biodiversity but also to create awareness among to poor farmers through the proper utilization of their derelict ponds or shallow swamps those are unsuitable for carp/ shrimp culture. Considering the above facts the present study was design to observe the effects of various feed ingredients in terms of growth and survivality of *C. batrachus* larvae under field condition.

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2.0. MATERIALS AND METHODS

2.1 Site selection and Duration of the study:

The experiment was conducted in Khulna University campus during October 2003 to May 2004. Biological data of sampled species and other parameters were carried out in fish physiology and fish nutrition lab of Fisheries and Marine Resource Technology Discipline, Khulna University. The experimental protocols are described below.

2.2 Pond preparation:

2.2.1 Size and shape:

Eight mini earthen ponds were used in this experiment. Each pond was almost equal in size of 40 m^2 and rectangular in shape.

2.2.2 Treatments and replication:

There were three Treatments on the basis of feed and one Treatment was without feed applied in the experiment. The Treatments using feed were indicated as T_1, T_2 and T_3 and rest one treatment was indicated as T4. Each treatment consisted of two replications.

2.2.3. Liming and Fertilization:

Before stocking, the ponds were dried by sun for several days. One week prior to stocking lime was applied at the rate of 1kg/ decimal. Fertilizer viz. Urea, TSP and Cowdung were used after five days liming. Doses are presented in table (1). Then the ponds were filled with water and the experimental fish was stocked. The ponds were numbered to apply treatment. The numbering was done randomly using lottery system. The average water depth of these experimental ponds was 60 cm.

Table 1: Doses of different organic and inorganic fertilizers used during the culture period

Fertilizer	Dose (gm/dm/wk)	Dose (kg/ha/yr)
Urea	100	1284.4
TSP	50	542.2
MP	25	321.1
Cow dung	200	2568.8

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2.3. Feed preparation:

2.3.1 Selection of feed ingredients:

Selection of feed ingredients, proximate analysis of feed ingredients' composition, feed formulation and manufacturing, determination of feed composition, feed cost and diet quality were assessed. Locally available feed ingredients considering both protein supplement and price were considered for feed formulation.

2.3.2. Collection of feed ingredients:

For the formulation of experimental diets, different feed ingredients such as fish meal, blood meal, wheat flour, wheat bran, soyabean oil, and soyabean oil cake, shark oil multivitamin GS, pure vitamin C and paga binder were collected from the local market. Three feeds were formulated with different types of feed ingredients and the compositions are shown in table 2.

Table 2: Different feed ingredients used in different feeds

Treatments	**T_1**	**T_2**	**T_3**
Ingredients	Blood meal	Fish meal	Blood meal
	Wheat flour	Wheat bran	Fish meal
	WFBP*	WFBP	WFBP
	Soybean oil	Soybean oil	Soybean oil
	Soybean oil cake	Soybean oil cake	Soybean oil cake
	Shark oil	Shark oil	Shark oil
	Multivitamin GS	Multivitamin GS	Multivitamin GS
	Pure Vitamin C	Pure Vitamin C	Pure Vitamin C
	Paga Binder (synthetic binder)	Paga Binder (synthetic binder)	Paga Binder (synthetic binder)

*WFBP-Wheat flour by product

2.3.3. Ingredient analysis:

Three types of feeds were made considering the protein level of 45%. The composition of the feed ingredients was analyzed and is shown in table 3. The three experimental feed were used in the study are given in table 5, 6 and 7 for the treatments T_1, T_2 and T_3 respectly. Here

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multivitamin GS, pure Vitamin C and paga binder were mixed with the proximate diets as premixes at the rate of 2.5, 0.5 and 6 g /kg of feed.

Table 3: Feed ingredients and their proximate composition used to the experimental ponds

Ingredients name	Protein % (dry weight basis)	Moisture %
Blood meal	84	25.59
Fish meal	55	20.13
Wheat flour	16.23	18.26
Wheat bran	17.26	20.32
Soya bean meal	52	15.5

Table 4: Proximate composition of prepared feed

Ingredient	T_1		T_2		T_3	
	Dry Weight (Kg)	Protein (%)	Dry Weight (Kg)	Protein (%)	Dry Weight (Kg)	Protein (%)
Fish meal	0	0	54.21	29.82	20.45	11.25
Blood meal	28.03	23.63	0	0	20.44	17.24
Wheat flour	10	1.62	10	1.62	10	1.62
WFBP	29.93	5.17	8.55	1.47	24.65	4.25
Soybean oil	28.03	14.57	23.23	12.08	20.45	10.64
Soybeanoilcake	2	0	2	0	2	0
Shark oil	2	0	2	0	2	0
Multivitamin GS	0	0	0	0	0	0
Pure Vitamin C	0	0	0	0	0	0
Paga binder	0	0	0	0	0	0
Total	**99.99**	**44.99**	**99.99**	**44.99**	**99.99**	**45**

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2.3.4. Feed manufacture

The feed were prepare in the following manner fig. 1.

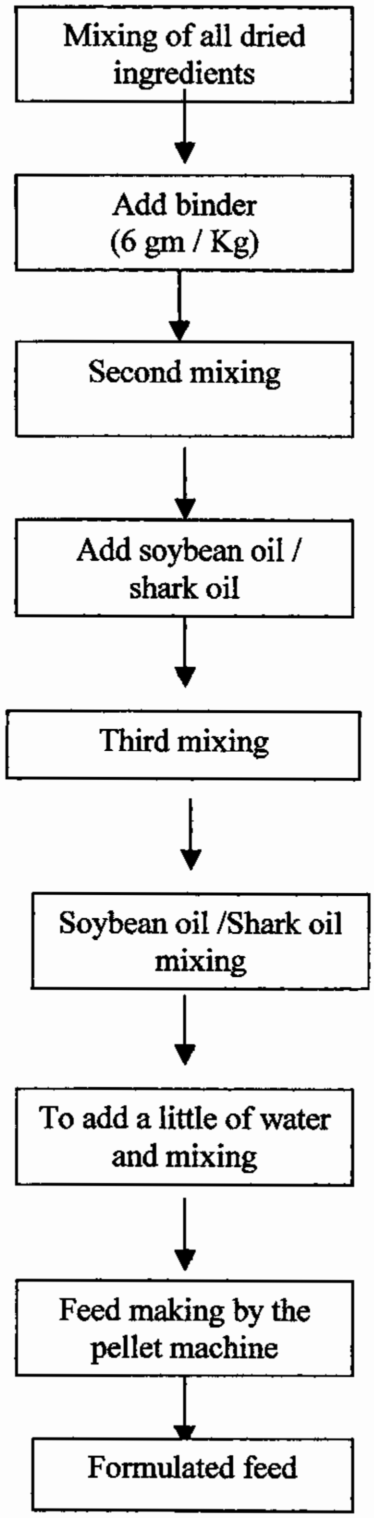

Fig.1. Flow chart of feed preparation process

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2.4. Proximate analysis of the test diets:

Proximate composition of the test feeds were determined by following the standard methods given by Association of Official Analytical Chemists (AOAC, 1980), Determination of protein and moisture was conducted in the laboratory of fish nutrition, Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna. The proximate composition of different feeds is shown in Table 5.

2.4.1 Principle of crude protein

The procedure involves two steps: (a) digestion of the sample to convert total N to ammonium sulphate and (b) determination of nitrogen in the digested sample through distillation process.

Procedure

About 0.2-0.5 g sample was taken in a Kjeldahl flask and about 2 g resolvent was added into the flask. About 5 ml of concentrated sulfuric acid was added Then the flask was kept on to a Kjeldahl nitrogen digesting apparatus and heated ,After digestion, the flasks were removed from the digestion chamber then 70 ml distilled water was poured slowly along the flask's inner wall and 0.5g of sandy zinc was also added to the mixture. About 25 ml of 33-40% sodium hydroxide (NaOH) solution (containing 1% potassium sulfide) was poured slowly along the flask's inner wall and washed down the remaining solution on the mouth with a small amount of water. The flask was then placed to the Kjeldahl nitrogen distillation apparatus (model no. OSK 8416A, OGAWA SEIKI CO. Ltd) and connecting the sample flask with the distillation plant, 10-20 ml of 2% boric acid was taken in another Erlenmeyer flask (conical flask) and 2-4 drops of Tashiro's indicator was added into it. Then the distillation tube was poured into the Erlenmeyer flask so that the end of the glass tube was immersed in the boric acid solution. Distillation procedure was continued for about 30 minutes to obtain about 30 ml distilled solution. After completion of distillation, the solution was titrated against 0.1 N hydrochloric acid (HCl).

Calculation:

$$\% \text{ Total nitrogen } (\% \text{ N}) = \frac{\text{Ttitrant (ml)} \times \text{Strength of titrant} \times 0.014}{\text{Weight of sample (g)}} \times 100$$

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% Crude protein = % N × 6.25 (Pearson, 1976)

2.4.2. Moisture

The moisture content (%) in sample was determined by using an electric Moisture determination apparatus (model no. MA 30 – 000V3, SARTORIUS AG Gottingen, Germany).

Table 5. Proximate analyses (% dry matter basis) of the experimental feed

Treatments	T_1	T_2	T_3
Protein %	45	45	45
Moisture %	(15)	(12)	(12)

2.5. Stocking density and sources of fry:

Seven weeks old fingerlings of the experimental fish (*C. batrachus*) were collected from the laboratory of fish breeding, Fisheries and Marine Resource Technology Discipline, Khulna University. The stocking densities were same in all the experimental ponds at the rate of 500 individuals per decimal (12.5 individuals / m^2) with initial weight of fingerlings as 2.89±0 g.

2.6. Feeding Practice:

Experimental feed was given twice a day at 9.0 hrs and 17.0 hrs regularly. During the first three months fish fed at the rate of 5% body weight of the experimental species. Next two months were given formulated feed at the rate of 3% body weight and finally last two months it was 2% of the body weight (Table 6). The amount of feed was adjusted fortnightly on the basis of sampling.

Table 6: Feeding strategy applied to the experimental ponds

Feeding treatment	Pond no	Feed as percentage of body weight of total biomass (%)		
		First 3 months	Next 2 months	Last 2 months
T_1	P_2	5	3	2
	P_8			
T_2	P_3	5	3	2
	P_9			
T_3	P_4	5	3	2
	P_{10}			
T_4	P_{13}	-	-	-

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2.7. Data collection:

2.7.1 Sampling procedure:

At every 15 days of interval *C. batrachus* fry were sampled by cast net at 5% of the total stocking from experimental ponds of all treatments. Total length and weight were recorded using measuring scale, and digital balance (B303-s) respectively. The fry were released in the respective ponds after recording the length (cm) and weight (g).

Growth rate

The growth rate (by weight) of the Magur was calculated according to Mahmud *et al.* (1993):

$$\text{Growth Rate: (g/day)} = \frac{\overline{W}2 - W1}{T2 - T1}$$

Where,

W2 = Weight (g) at time T2

WI = Weight (g) at time T 1

T 2 = Date of last sampling.

T 1 = Date of previous sampling.

Specific growth rate (%):

According to Elangovan and Shim (2000), the specific growth rate of magur was determined.

$$\text{Specific growth rate\%} = \frac{\text{In final weight (g)} - \text{In initial weight (g)}}{\text{Time (days)}} \text{X100}$$

2.7.2. Survival rate (%)

The survival rate was calculated by using the following formula:

$$\text{Survival rate \%} = \frac{\textit{Stock at harvesting time}}{\textit{Total no.of stocked}} x100$$

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2.7.3. Determination of the quality of diet

The qualitative value of feed was evaluated by the following parameters (De silva and Anderson, 1995).

$$\text{FCR (feed conversion ratio)} = \frac{\text{Mass of food consumed (Dry)}}{\text{Increase in mass of animal produced (wet)}}$$

$$\text{PER (protein efficiency ratio)} = \frac{\text{Increase in the mass of animal produced (wet Wt)}}{\text{Mass of protein in fed (dry Wt)}}$$

2.7.4. Water quality measurement:

Before stocking water quality was monitored. During culture period some water quality parameters was checked fortnightly. Among the water quality parameters temperature was recorded using a Celsius Thermometer, pH by pH meter, Dissolve Oxygen (DO) and alkalinity were measured by Winkler method and titration method.

2.8. Harvesting

Harvesting was done after seven months of culture by dewatering the ponds.

2.9. Data Analysis:

Data was analyzed using different statistical packages. One way analysis of variance (ANOVA) was performed at 5% significance level to determine the effects of water quality, FCR, SGR%, survivality, production according to Duncan's New Multiple Range Test.

2.10. Cost-benefit analysis:

Cost benefit ratio was evaluated by using the following formula given by (Loudon and Loundon, 2000).

- Total cost (Tk) = Fertilizer (Tk) + liming (Tk) + feed (Tk) + fry (Tk) +miscellaneous (Tk).
- Miscellaneous (Tk) = Labour + night guard cost.
- Total yield (Kg/ha) = Gross production.
- Total income (Tk) = Commodity selling price per unit × Total yield.
- Total net income (Tk) = Total income (Tk)- Total cost (Tk)
- Rate of return % = Total income (Tk)/ Total cost (Tk) × 100.

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3.0. RESULT AND DISCUSSION

3.1 Water quality parameters:

During the culture feeding trail period Temperature, Dissolve oxygen, pH and alkalinity were measured regularly as routine work. Mean values of these parameters are presented in (Table 7):

Table 7: Different water quality parameters observed during the culture period

Parameter	Treatments			
	T_1	T_2	T_3	T_4
Temperature Morning (^OC)	$27.53^a \pm 2.83$	$27.59^a \pm 2.83$	$27.75^a \pm 2.12$	$28.75^a \pm 1.77$
Temperature Evening (^OC)	$30.52^a \pm 0.07$	$30.59^b \pm 2.12$	$31.00^a \pm 1.14$	$30.25^{ab} \pm 0.07$
pH Morning	$7.34^a \pm 0.23$	$7.42^c \pm 0.16$	$7.31^a \pm 0.22$	$7.52^b \pm 0.22$
pH Evening	$7.9^b \pm 0.25$	$7.96^b \pm 0.2$	$7.81^b \pm 0.21$	$8.25^a \pm 0.21$
DO(mg/l) Morning	$7.7^a \pm 0.81$	$7.23^a \pm 0.4$	$7.3^a \pm 0.36$	$7.5^a \pm 0.25$
DO(mg/l) Evening	$7.73^a \pm 0.81$	$7.26^a \pm 0.43$	$7.43^a \pm 0.23$	$8.43^a \pm 0.29$
Alkalinity (mg $CaCO_3$/l)	$297.08^c \pm 55.88$	$255.17^d \pm 37.8$	$303.13^a \pm 88.29$	$271.15^b \pm 21.11$

Values within the same row having the same superscripts show no significant different ($P>0.05$)

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3.1.1. *Temperature:*

Temperature is the essential factor for maximum growth attain specially for cat fishes. During the study period the temperature was measured fortnightly during morning and evening. The maximum (28.75±1.77°C) and minimum (27.53±2.83°C) temperature was found for treatment T_4 and T_1, respectively in the morning season (Fig 2). During the evening season the temperature was higher for all treatments from morning season. The maximum (31±1.14°C) and minimum temperature (30.25±0.07°C) was found for treatment T_3 and T_4, respectively in the evening season. The temperature of the present study was within the culturable range. Saha *et al.* (1998) found that temperature range from 28.05± 0.72 to 29.02±0.28°C was suitable for cat fish rearing when they conducted the experiment on the effect of formulated diets on the growth and survival of stinging catfish *Heteroneustes fossilis* fry at the laboratory of Aquaculture, Bangladesh Agricultural University, Mymensingh during the month of July 1995. In Bangladesh, the favorable temperature for fish culture is 25 ^{0}C to 32^{0}C but fish grows all the year round and there is no problem of very low temperature. Generally 20-35^{0}C and 25-30^{0}C (Sarker, 2000) ranges

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are considered to be optimum for fish culture. Ali *et al.* (1982) stated that 20.5-36.5^0 C is favorable for fish culture but Rahman *et al.* (1982) stated the favorable temperature is 26.06-31.97^0 C. Ling (1969) suggested that 22- 32^O C is suitable for fish culture. During the study period the value of temperature were varied among 27^{0}C and 31^0 C which were suitable for this study (Table 7).

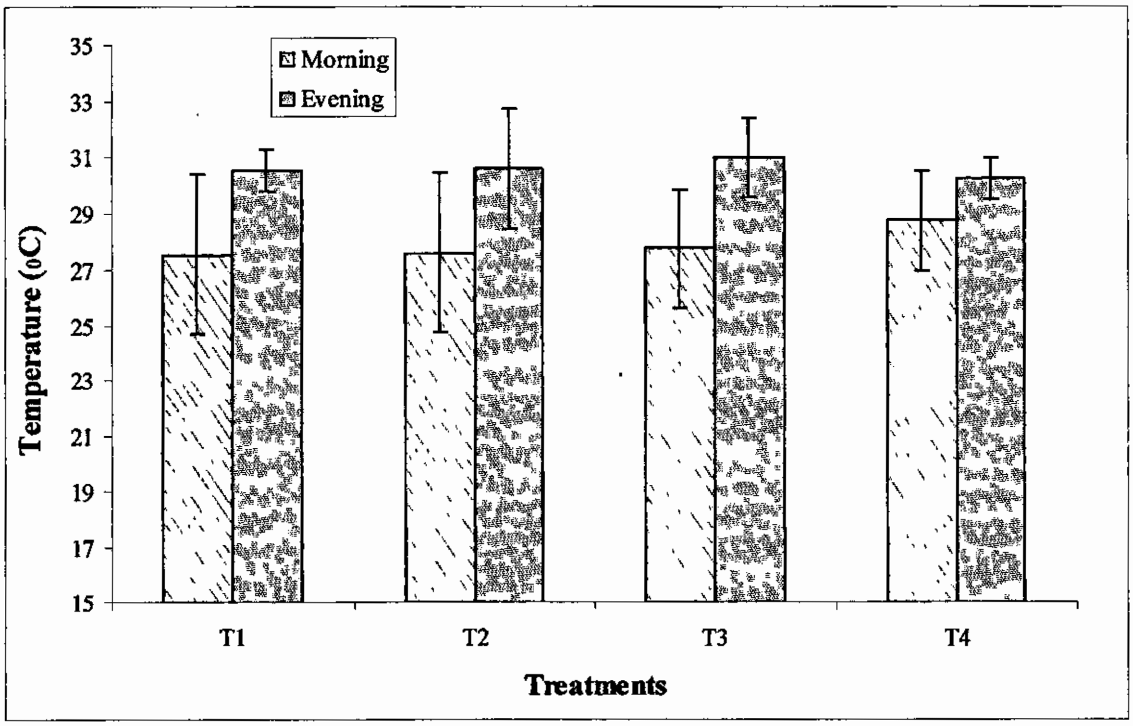

Fig. 2: Temperature differences among treatments in morning and evening

3.1.2. *Dissolve oxygen (DO):*

The highest (7.7±0.81mg/l) and lowest (7.23±0.4 mg/l) DO was found for treatment T_1 and T_2, respectively in the morning season (Fig 3). During the evening season the DO was higher for all treatments from the morning season. The result might be due to higher temperature at evening. The highest (8.43±0.29mg/l) and lowest DO (7.26±0.43mg/l) was found for treatment T_2 and T_4, respectively (Table 7). *C. batrachus* have accessory respiratory organs enablling them to breath atmospheric air (Panayotou *et al.* 1982) and permit the fish to exist at a reduced oxygen level (Stickney, 1979). Saha *et al.* 1998 found DO range 5.50±0.74 to 5.63±0.61mg/l for catfish culture at laboratory condition. The result

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is lower than present study and the probable cause might be the experiment was in laboratory. Rahman (1997) stated that oxygen concentration is higher in winter season and lower in summer season due to inverse relation of dissolved oxygen with temperature or due to cold temperature of water as the cold water has the greater oxygen holding capacity. Pahwa and Mehrota (1966); Dewan (1973) and Islam *et al.* (1983) found almost same results. In general, an acceptable environment for aquatic life must contain not less than 5 ppm of oxygen. *Cyprinous carpio* can remain alive in water containing as little as 1-2 ppm dissolved oxygen (Andrew *et al.* 1972). Various observations have been made on critical as well as optimum level of DO in pond water. Boyd (1978) stated that minimum concentration of DO tolerated by fish is obviously functioning of exposure time. A fish might survive 0.5 ppm DO for a few hours but not for several days. Ellis (1937) indicated that 3.0 ppm DO or less should be regarded as hazardous for fish and suitable DO level should be 5.00 ppm or more. Mckee and Wolf (1963) stated that DO for worm water fish habitat should not be less than 5 ppm at least 16 hour of any day. Bhuyan (1970) reported that dissolved oxygen content from 5.0mg/l to 7 mg/l is required for high production.

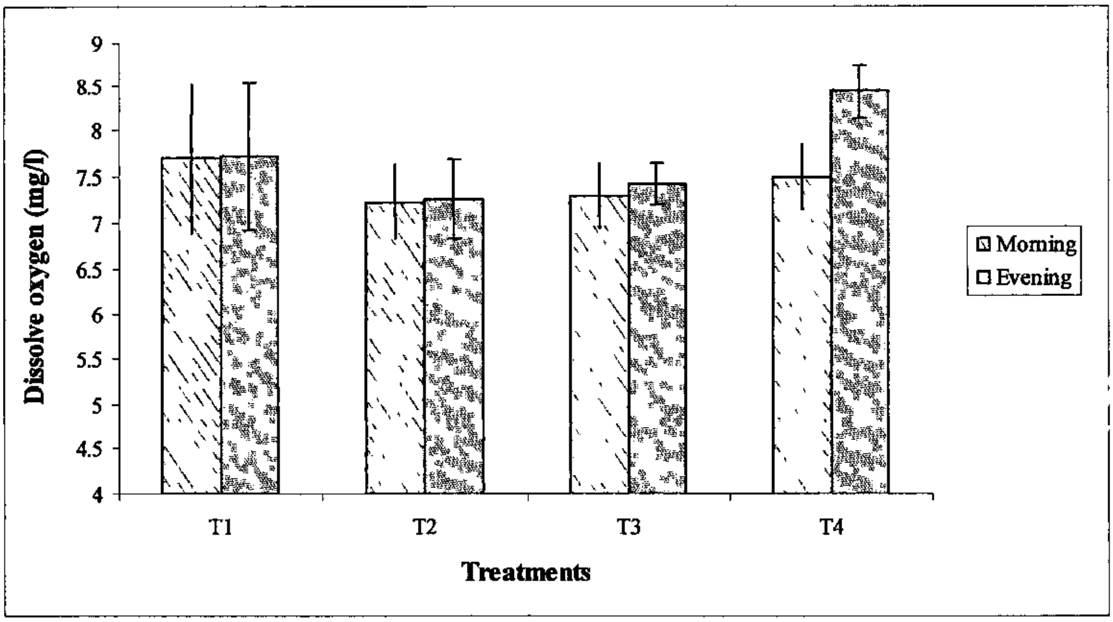

Fig. 3: Dissolve Oxygen differences among treatments in morning and evening

3.1.3. *pH*

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The highest (7.52±0.22) and lowest (7.31±0.22) pH was found for treatment T_4 and T_3, respectively in the morning season (Fig 4). The highest (8.25±0.21) and lowest pH (7.9±0.25) was found for treatment T_4 and T_3, respectively in the evening. There was no significant difference were found between T_1 and T_3 in the morning ($P>0.05$) while there was significant difference between T_2 and T_4. The pH is also called productivity index of water body. The variations in the values of pH were marginal and were almost similar throughout the study period. Alam *et al.* (1996) reported that pH values ranged from 6.65 to 7.80 suitable for fish culture. He stated that the higher value of pH was found in early August which might be due to the increased rate of photosynthetic activities of phytoplankton with concomitant decrease of carbon dioxide. The increased values of pH might be due to decrease of carbon dioxide and precipitation $CaCO_3$. Saha *et al.* 1998 found pH ranged from 7.78±0.18 to 7.95±0.17 for catfish culture at laboratory condition. Michael (1968) reported that the best pH for fishes is 7.5 to 8.5 as observed in the present study. The pH value ranged from 7.5 to 8.5 was suitable for *M. rosenbergii* in earthen ponds (Jia-Mo *et al.* 1988). Hoq *et al.* (1996) reported that pH ranged from 7.5-8.0 in five prawn farmers ponds. Hossain *et al.* (2000) reported that pH ranged from 6.8 to 8.4 was suitable for *M. rosenbergii.* The observed pH values from the present study agreed well with the findings of Hossain *et al.* (1997) who found the pH range 6.7 to 8.3 and Kohinoor *et al.* (1998) who obtained the pH range of 7.18 to 7.24 in the research ponds of Bangladesh Agricultural University Campus.

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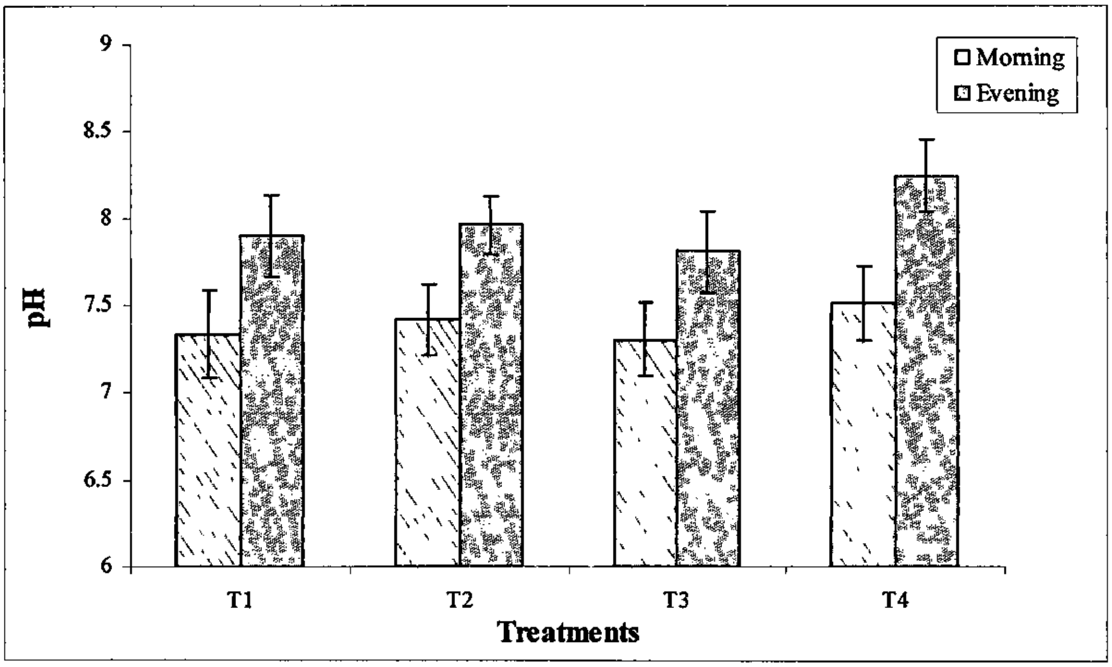

Fig. 4: pH differences among treatments in morning and evening

3.1.4. *Alkalinity:*

The highest (303.13±88.29 mg $CaCO_3$/l) and lowest (255.17±37.8 mg $CaCO_3$/l) alkalinity was found for treatment T_3 and T_2, respectively (Fig 5). Alikunhi (1957) stated that the highly productive water bodies should have more than 100mg/l alkalinity. Chisty and Rahman (1999) stated that total alkalinity of 100 mg $CaCO_3$/l to 175 mg $CaCO_3$/l indicates good water quality. From the above discussion it might be concluded that the values obtained in this experimental ponds were suitable for *Clarias batrachus* culture.

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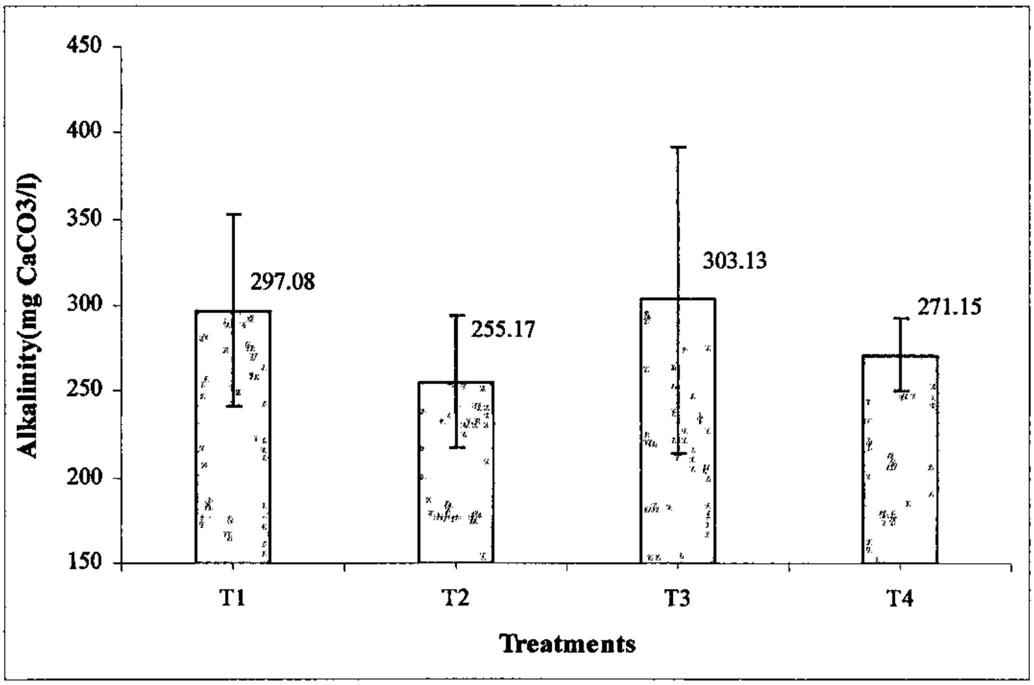

Fig. 5: Alkalinity differences among treatments during the study period

3.2. Growth performance:

Overall growth performance in respect of weight (g) and specific growth rate (SGR %) of *C. batrachus* fingerings under different diets are summarized in table 8. Mean final weight at the end of seven months in the treatments of T_1, T_2, T_3 and T_4 were 46.19± 1.9g, 80.54±2.65g, 61.8±3.28g and 7.39±0.72 g, respectively. The highest growth was observed in T_2 while the lowest was found in T_4. Among the treatments, mean final growth differed significantly ($P<0.05$) with each other. In case of SGR% same trends was observed as found in growth but not differed significantly in some treatments (Table 8). The SGR in T_1, T_2, T_3 and T_4 were 2.17, 2.6, 2.49 and 0.12 %/day, respectively. The figure 6 shows the fortnightly growth pattern of the experimental species in four different treatments. From the results it was found that growth in treatment T_2 was always in better position than in treatment T_4. In treatment T_4 no feed was provided, depends on natural food.

Protein is the basic component of animal tissues and is, therefore, an essential nutrient for both maintenance and growth. At maintenance level the fish requires protein for replacement of worn-out tissues and protenous production such as intestinal epithelial cells,

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enzymes and hormones, which are vital for the proper function of the body, and are recycle quite rapidly. The requirement of protein for the synthesis of new tissues is obvious, since protein constitutes 45-75% of the tissue dry matter. The capacity of the fish to synthesize protein from carbon skeletons is limited, and most of the protein must therefore be supplied through the diet. Thus the content of protein in the diet and its ratio to the metabolizable energy becomes of prime importance.

Protein level of all prepared feeds in this experiment was adjusted as 45% with varying ingredient composition. In T_2, ratio of fish meal was higher while in T_3 and T_1 protein source is replaced by blood meal. The main purpose of replacement of protein source is due to reduce the feeding cost. On the other hand, laboratory analysis revealed that the level of protein (%) in blood meal (84%) and in fish meal (55%) differs significantly (Table 8). Though protein level of all experimental diets of the study was same but better result was obtained in T_2 where protein source derived from only fishmeal. The hyposthesis of this study, replacement of protein source by blood meal is completely failed, but suggests two important things (1) proportion of essential amino acids in the protein of blood meal and (2) ratio of blood meal incorporated with other ingredients during feed preparation.

Cowey (1990) reported that some selected feed staffs have high levels of crude protein, but that the amino acids balances differ. Amino acids are building block of protein formation. When one amino acid is lacking or insufficient in the diet, protein formation can be delayed or decreased resulting poor growth of fish. Working with salmon culture by Cowey (1990), fish meal from herring (68% crude protein) perform better growth than those of other feed staffs. There are around 20 amino acids needed for protein formation, of these amino acids, 10 are essential must have to be included in the diet. The other amino acids can be formed or synthesized in the body; hence they are called non-essential amino acids. It is evident that the ratio and requirement of amino acids are species-specific. The score of amino acids composition in protein content in ingredients used for this experiment were not determined, but it is predicted that all essential components of amino acids or requirement of essential acids in blood meal are not sufficient for the growth of *C.*

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batrachus fingerlings. This could attribute to the lower growth of the fingerlings compared to the other diets (T_2 and T_3). Cowey (1990) also concluded that fish meal (Herring) would fully meet the essential amino acids requirements of trout than blood meal when the chemical scores of protein of other feed staffs were compared. This experiment, comparing with three diets, clearly supports his idea. In contrast to chemical score of protein, the ratio of protein sources incorporation in prepared diet is a crucial in respect of cost effectiveness of diet. Present findings reveal that growths of sampled fingerlings significantly accelerate when feed was prepared with fish meal and blood meal than solely with blood meal. Therefore, it is recommended that not only protein source but also mixing ratio of protein rich ingredients important for diet manufacturing during commercial aquaculture operation.

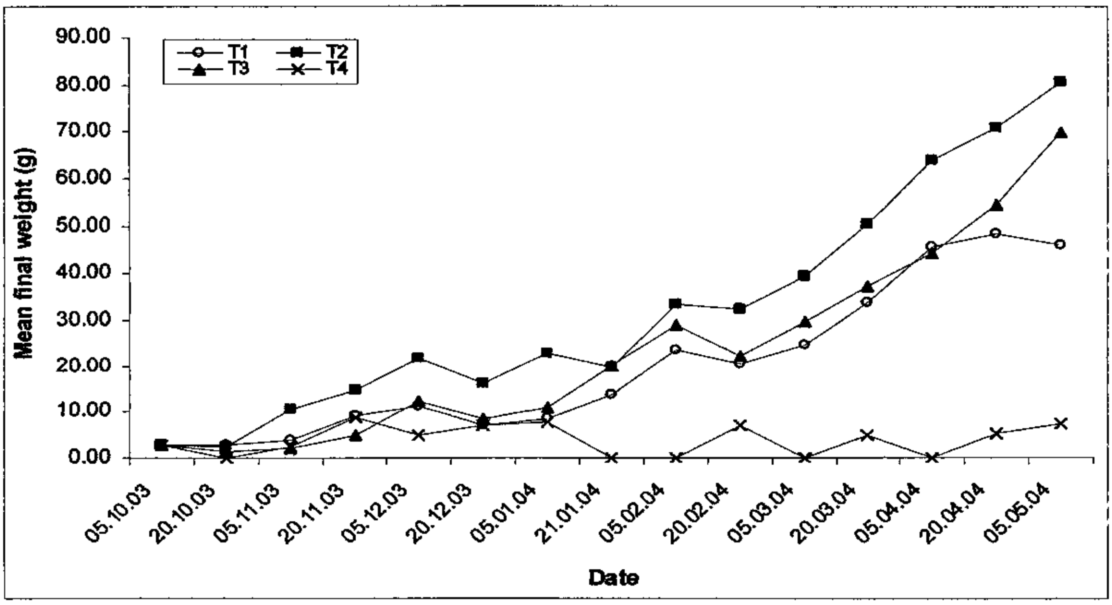

Fig 6: Fortnightly growth performance in four different treatments

3.3 Survival rate:

At the end of the experiment total individuals were harvested and counted. Average survival rate in each experiment was 58.2±3.49%, 65.4±3.06%, 62.6±2.66% and 21.6±1.73% for T_1, T_2, T_3 and T_4, respectively. Survival rate of T_4 significantly ($P>0.05$) differ with other treatments (T_1, T_2 and T_3) while no significant difference was observed among the treatments of T_1, T_2 and T_3. Lowering of survival rate found in T_4 due to absence of feeds. This findings support with the results obtained by Hussain *et al.* (2001).

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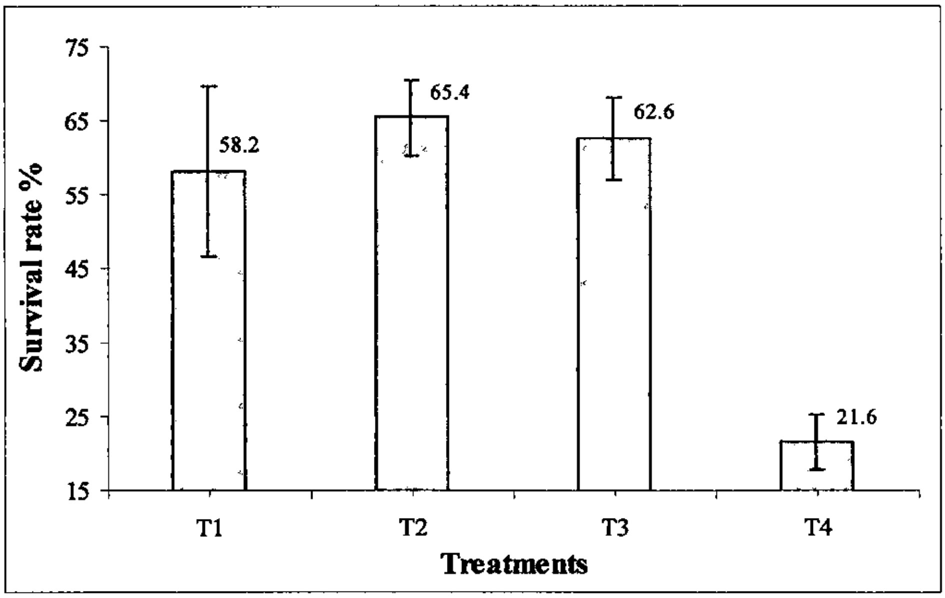

Fig 7: Survivality in four treatments.

In the present study the survival rate was lower than the result of Mollah and Alam (1988) when he found highest survival rate (82.4%) in T_4 and T_1 treatment where the diet contained 45% and 30% protein, respectively. Alam and Mollah (1989) reported the survivability of 74% by using moist diet, which is lower than the present findings. Latif *et al.* (1998) reported 15 days old *C. batrachus* larvae fed on *Tubifex* sp. for 56 days showed a survival rate about 66.66%. Polling *et al.* (1988) found that *C. gariepinus* larvae fed on zooplankton and *Artemia* exhibited survival rate more than 96% which is supported by this study. Differences with other findings may be due to differences in the lipid and other content of the diets. Lower lipid content may be reason for higher mortality (Alam and Mollah, 1989). Saha *et al.* (1995) found 76.67% survival of *Heteropneustes fossilis* when they use 40% fishmeal in their dietary experiment and that was highest than the other treatments where there was no fishmeal.

3.4. FCR:

From the experiment it was found that the FCR of the different treatments were 2.74, 2.75 and 2.94 in T_1, T_2 and T_3, respectively (Fig 8). From the experiment it was revealed that FCR was highest when the feed was formulated with the mixture of blood meal and fish meal.

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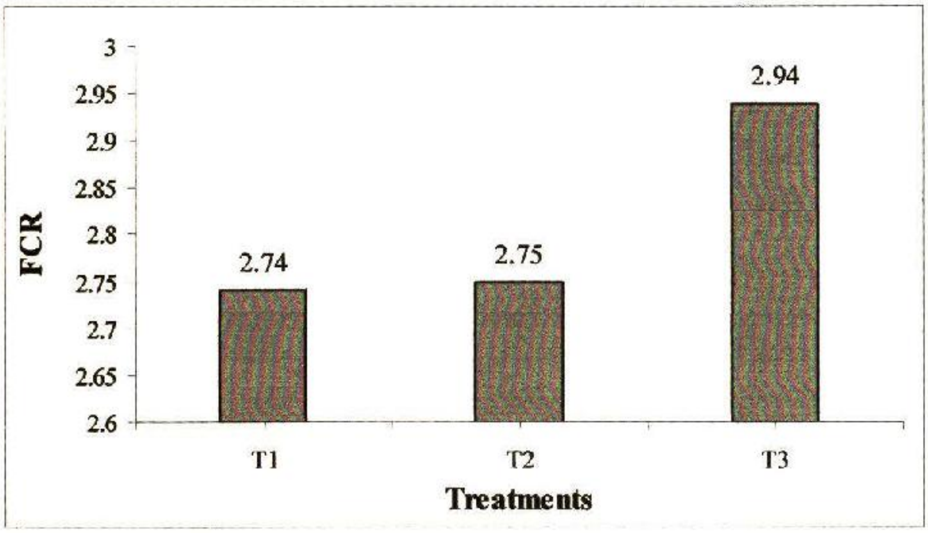

Fig 8: FCR differences among the treatments after harvesting

Azimuddin *et al.* (1999) observed that the FCR varied from 1.73 to 2.04 for the growth of Thai pangus in net case feed on formulated diet, which is comparatively lower than that of present study. Das, *et al.* (1990) stated that FCR of prepared pellets varied from 2.94 to 6.3 which are higher of the present findings.

3.5. SGR%:

In the present study, the specific growth rate of the four treatments were 2.17g/day, 2.6g/day, 2.39g/day and 0.12g/day from T_1, T_2, T_3 and T_4, respectively (Fig 9).

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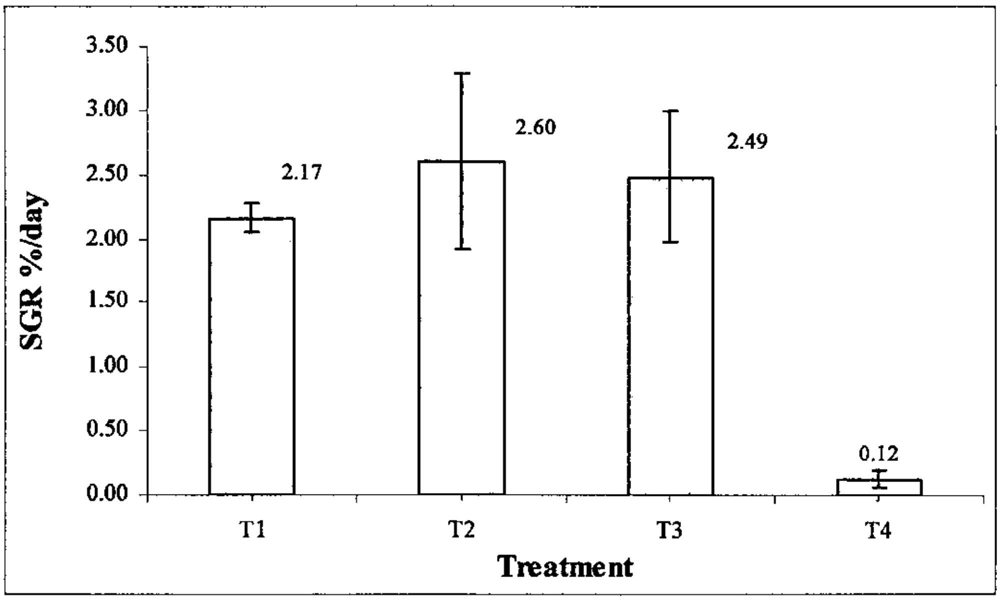

Fig 9: SGR% differences among the experiments after harvesting

Islam (2003) found SGR% 7.42 ± 0.27g/day using formulated feed to the *C. batrachus* fry in the laboratory condition. Asadujjaman *et al.* (1998) found the highest SGR% (2.04) containing 30% protein for growth of *Catla catla* by artificial feed.

3.6 Production:

Seven months culture in the experimental ponds, the mean weight gains were found 43.3g, 77.65g, 61.91g and 4.5g from the treatment of T_1, T_2, T_3 and T_4, respectively. The highest mean weight gain (77.65g) was found in T_2 while the lowest (4.5g) was found in T_4. The highest production (21.39 kg/dm/7month) per pond was found after seven month culture in T_2 while the lowest production (16.94 kg/dm/7month) was found in T_1. Incase of T_4, the production (0.486 kg/dm/7month) was very much poor, because the species was carnivorous in character. The experimental fish needs highly supplementary proteneous feed for its proper growth. The production from per hectare pond was 7172.88, 9057.18, 8294.97 and 205.79 kg/ha/year in T_1, T_2 T_3 and T_4, respectively (Table 8). Number of individual stocked, no of harvested its survival, initial weight, final weight, final weight gain, FCR, yield per pond and yield per hectare per year was given in table 8.

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Table 8: Yield parameters of experimental species in three experimental ponds

Parameters	**Treatment**			
	T_1	T_2	T_3	T_4
No. of stocked	500	500	500	500
No. of harvested	291	327	313	108
Survivality (%)	$58.2^{a} \pm 3.49$	$65.4^{a} \pm 3.06$	$62.6^{a} \pm 2.66$	$21.6^{b} \pm 1.73$
Mean initial weight(g)	2.89±0	2.89±0	2.89±0	2.89±0
Mean final weight (g)	$46.19^{b} \pm 1.9$	$80.54^{d} \pm 2.65$	$61.80^{c} \pm 3.28$	$7.39^{a} \pm 0.72$
Net weight gain(g)	43.3	77.65	58.91	4.5
FCR	$2.44^{a} \pm 0.55$	$2.76^{b} \pm 0.20$	$2.64^{ab} \pm 0.09$	
SGR (%/day)	$2.17^{ab} \pm 0.11$	$2.60^{b} \pm 0.89$	$2.39^{a} \pm 0.71$	$0.12^{c} \pm 0.47$
Yield(Kg/dm/7 months)	16.94^{a}	21.39^{b}	19.59^{ab}	0.486^{c}
Yield (Kg/ha/Year)	7172.88^{a}	9057.18^{b}	8294.97^{b}	205.79^{c}

With *Heteropneustes fossilis*,Hossain and Parween (1998) found total net production 254 g/m^2 and 345.5 g/m^2 using Feed A and Feed B, respectively. When they cultured *Heteropneustes fossilis* for three months in Rajshahi. Feed A contained mixture of rice bran (40%), wheat bran (40%), chicken entrails (20%) and feed B contained the mixture of rice bran (2g), wheat bran (2g) and blood (10 ml). From the present study it was revealed that the T_2 performed better when the feed was mixed with mixture of rice bran (2g), wheat bran (2g) and blood (10 ml).

3.7. Cost benefits analysis:

After harvesting cost benefit analysis was estimated. Table 9 shows the total operation cost of the four different treatments in the study. The fingerlings were found from the laboratory of fish breeding, Fisheries and Marine Resource Technology Discipline of Khulna University. Notwithstanding to find out the real scenario in the expenditure, the cost of the fingerlings were taken into account in the cost benefit analysis. After harvesting the experimental species were sold in the local market to find out the benefit of the study. The fishes of different treatments were sold separately. Final weights of the experimental fishes of the three experiments were not same. The fishes of treatment T_2 was sold at higher price due to attaining the highest size. The prices were 200, 260, 240 and 50 Tk/ kg for T_1, T_2 and T_3 and T_4, respectively. Total cost was estimated of the three different treatments were 2946, 3759, 3492 and 1686 Tk / dm for the treatment of T_1, T_2, T_3 and T_4, respectively (Table 9).

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Table 9: Total expenditure per decimal of the four treatments in the study

Production cost	Treatments											
	T_1			T_2			T_3			T_4		
Item	**Quantity**	**Unit price (Tk)**	**Cost (Tk)**	**Quantity**	**Unit price (Tk)**	**Cost (Tk)**	**Quantity**	**Unit price (Tk)**	**Cost (Tk)**	**Quantity**	**Unit price (Tk)**	**Cost (Tk)**
Pond preparation			50			50			50			50
Fingerlings	500	2	1000	500	2	1000	500	2	1000	500	2	1000
Lime	1 kg	8	8	1 kg	8	8	1 kg	8	8	1 kg	8	8
Fertilizers (Pond preparation)												
Cow dung	5 Kg	02Tk/Kg	10	5 Kg	02Tk/Kg	10	5 Kg	02Tk/Kg	10	5 Kg	02Tk/Kg	10
Urea	250 g	8 Tk/Kg	2	250 g	8 Tk/Kg	2	250 g	8 Tk/Kg	2	250 g	8 Tk/Kg	2
TSP	125 g	16 Tk/kg	2	125 g	16 Tk/kg	2	125 g	16 Tk/kg	2	125 g	16 Tk/kg	2
Fertilizers (During culture)												
Cow dung	7 Kg	02Tk/Kg	14	7 Kg	02Tk/Kg	14	7 Kg	02Tk/Kg	14	7 Kg	02Tk/Kg	14
Urea	3.25 Kg	08 Tk/Kg	26	3.25 Kg	08 Tk/Kg	26	3.25 Kg	08 Tk/Kg	26	3.25 Kg	08 Tk/Kg	26
TSP	1.50 Kg	16 Tk/kg	24	1.50 Kg	16 Tk/kg	24	1.50 Kg	16 Tk/kg	24	1.50 Kg	16 Tk/kg	24
Feed (Wet weight)	50 Kg	25.2Tk/Kg	1260	66 Kg	31.41Tk/Kg	2073	64.5 Kg	28 Tk/Kg	1806	–	–	–
Miscellaneous			300			300			300			300
Net purchase	-	-	100	-	-	100	-	-	100			100
Transportation	-	-	50	-	-	50	-	-	50			50
Others	-	-	100	-	-	100	-	-	100			100
Total			**2946**			**3759**			**3492**			**1686**

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The gross income was 3388, 5134, 4310 and 25 Tk /dm from T_1, T_2, T_3 and T_4, respectively. Net highest income was found 1375 Tk/dm in T_2 where the feed was formulated with fish meal only. The highest and lowest return on investment percentage were found as 36.58% and 15% in T_2 and T_1, respectively where the feed were only with fish meal and blood meal, respectively (Table 10). By analysis marginal rate of return and investment, it can be calculated that treatment T_2 is the most profitable in context of lucrative economic return. In treatment T_4 no feed was applied and the stocking density was maximum (500 individual/dm). The lowering price in T_4 is due to high stocking density and no feed was applied. The present study was revealed that *C. batrachus* culture needs supplementary feed.

Table 10: Cost benefit analysis

Treatments	T_1	T_2	T_3	T_4
Gross income, Tk/ dm	3388	5134	4310	25
Total expenditure Tk/ dm	2946	3759	3492	1686
Net income Tk/ dm	442	1375	818	---
Net income Tk /ha	109174	339625	202046	---
Return on investment (%)	15	36.58	23.42	---

From the experiment, it was revealed that the growth performance and economic benefit was maximum in T_2 when the feed was formulated with fish meal and lowest was observed T_1 when it was blood meal only. In respect of growth, production and benefit T_2 was better for *C. batrachus* culture.

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Conclusion:

Cat fish, *C. batrachus* is carnivorous in natures and it needs high proteinous food for its proper growth. In this experiment, the ponds were categorized in to four groups namely treatments T_1, T_2, T_3 and T_4. Fingerlings under treatment T_1, T_2 and T_3 were fed blood meal, fish meal and in combination of fish meal and blood meal, while in treatment T_4 no feed was provided for fingerlings. Protein level of formulated feeds was adjusted at 45%. At the end of the experiment, fingerlings fed only fish meal (T_2) performed better in terms of growth, survivality and overall total income than those of other two feeds. Variations in growth rate among the treatments could be due to the availability of essential amino acids in the prepared feeds. Fish meal usually contains all required amino acids for fish growth. On the other hand, blood meals don't contain required amino acid that could reduce the fish growth. For fish the optimal amount of protein in formulated diet is important because both low and high protein levels resulting poor growth and increase susceptibility to disease and parasite. In the conclusion it can be suggested that fish meal might be used as the better feed ingredient to supply protein for *C. batrachus* culture.

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