EFFECT OF DIFFERENT REARING SYSTEMS ON THE GROWTH AND SURVIVAL OF GOLD FISH (*Carassius auratus*)

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ABSTRACT

The study was conducted to compare the effect of three different fry rearing systems such as: hapa, cistern and pond on the growth and survival of goldfish (*Carassius auratus*) fry. A total of 645 fry (mean initial weight: 0.0071 mg) were randomly distributed in the three treatments (systems) each having three replications. The stocking density was same in all the treatments with respect to the water volume of the systems which was 10 fry/hapa, 125 fry/cistern and 80 fry/pond. The trial lasted for 40 days. The water quality parameters were favorable in all the treatments during the period of the study. The growth and survival of goldfish fry varied among the systems. Highest average weight gain and specific growth rate (SGR) were observed in pond followed by hapa and cistern. On the other hand, survival rate was highest in cistern followed by hapa and pond. It can be concluded from the study that the pond was the best system in terms of growth rate and cistern was the best system for survival of gold fish fry.

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INTRODUCTION

Gold fish is the most popular ornamental fish used in Bangladesh. There are very few established hatcheries in the country where breeding of gold fish is performed. Breeding is mainly carried out in small scale. There is no available scientific information on the rearing of goldfish fry in Bangladesh. Mainly adult fish are preferred for keeping in aquarium for aesthetic purposes. The rearing of fry to adult stage may be critical both from biological and economic point of view. Fry may be reared in a wide variety of systems ranging from jars to ponds. The point to be considered is which system is more suitable. If fry are reared in jars or aquarium it may be expensive because cost will be incurred in the development of such system. Moreover they will have to be used with utmost care otherwise they will not last for long. Systems which are mainly used for the rearing of food fish fry may be used for fry rearing of gold fish. Most commonly used systems for fry rearing are ponds, hapas, and cisterns. Growth and survivability of fry vary among the systems. This is mainly due to differences in water quality parameters and availability of natural food. If maintained properly, these systems may be suitable for gold fish fry rearing. The study was carried out to compare the effects of different rearing systems on the growth and survival of gold fish fry.

MATERIALS AND METHODS

The experiment was conducted in the Department of Aquaculture, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh for a period of 40 days. In the experiment the growth and survival rate of *Carassius auratus* fry under different systems (hapa, cistern, pond) were assessed.

Experimental fry
Fourteen days old fry of *Carassius auratus* were used in this experiment. The fry had an initial average total length of 6.0 mm and weight of 0.0071 g.

System dimension
The experiment was conducted in 3 hapas, 3 cisterns and 3 small ponds. The size of each hapa was 75 cm × 60 cm × 60 cm, the size of each cistern was 210 cm × 180 cm × 90 cm and the size of each was pond 240 cm × 210 cm × 45 cm. The hapas were set in cisterns.

Preparation of the systems
The cisterns located behind the faculty of fisheries were properly cleaned and then sun dried for a day and filled with clean groundwater. The fine meshed hapa were set in different cisterns. Three newly dug ponds were limed at the rate of 1 kg/decimal. After 3 days these ponds were filled with clean groundwater and were fertilized by urea and TSP at the rate of 200 gm/decimal. All the systems were covered by nylon net to protect the fish from birds and other predators. One week after the preparation of the systems the 14 days old fry were stocked.

Experimental protocol
The hapa, cistern and pond systems were designated as T_1, T_2 and T_3 respectively. Each treatment had three replications: H_1, H_2, H_3 for T_1; C_1, C_2, C_3 for T_2 and P_1, P_2, P_3 for T_3. The stocking densities in T_1, T_2 and T_3 were 10 fry/hapa, 125 fry/cistern and 80 fry/pond.

Feed supply
Commercial feed named 'Mega feed' which had an approximate protein content of 34% was selected for the experiment. The fry were fed up to the satiation 3 times daily at 9:30 am, 1:00 pm and 4:00 pm. The powdered artificial feed was spread homogenously on the water surface of the systems (hapa, cistern, and pond). The fry were considered satiated when they stopped searching for food in about 30 minutes of food supply.

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Sampling of fish

Fish were sampled at 10 days interval. Ten fry were caught from each system by a hand scoop net, their lengths (mm) were measured by meter scale and weights (mg) were recorded by electronic balance.

Water quality parameters

Water temperature, pH and Dissolved oxygen (mg/l)

Water temperature (ºC) from each system was recorded by an alcohol thermometer, pH was measured by a digital pH meter (Jenway, Model 3020) and Dissolved oxygen was measured by a digital Dissolved Oxygen meter (YSI MODEL 58).

Nitrite

Nitrite was measured by nitrite testing kit. The procedure was as follows:
- The measurement vial was rinsed several times with the water to be tested and filled to the 5 ml mark. The vial was dried on the outside.
- **5** drops of reagent 1 and 2 was added each.
- The vial was shook until the liquid was evenly distributed.
- The colors were compared after five minutes. The vial was placed on the color chart and the colors were compared from a position above under natural daylight. Direct sunlight was avoided.

Ammonium (mg/l)

Ammonium was measured by ammonium testing kits. The procedures were as follows:
- The measurement vial was rinsed several times with the water to be tested and filled to the 10 ml mark. The vial was dried on the outside.
- Six drops of reagent 1 were added and shook until the liquid was evenly distributed.
- Six drops of reagent 2 were added and shook in the same manner.
- Six drops of reagent 3 were added and shook in the same manner.
- The color was compared after 5 minutes. Then the vial was placed on the chart and the color was compared from a position above under natural day light. Direct sunlight was avoided.

Alkalinity

Alkalinity was measured by alkalinity testing kit. The procedure was as follows:
- The test vessel was rinsed several times with the water to be tested and filled to 5 ml mark.
- One drop of indicator B+M was added and swirled. The solution turned greenish-blue.
- Titrant solution was added drop wise and the drops were counted. The solution was mixed slowly until the color changed to lavender-gray.
- One more drop was added and the solution turned orange. The number of drops used was counted and multiplied by 17 to obtain result in milligram per liter of calcium carbonate.

Growth and survival parameters of fish

Weight gain (g)

Weight gain (g) = Mean final weight (g) – Mean initial weight (g)

Specific growth rate (% per day)

$$\text{Specific growth rate (SGR)} = \frac{\log_e W_2 - \log_e W_1}{T_2 - T_1} \times 100$$

Where
W_1 = the initial live body weight (g) at time T_1 (day)
W_2 = the final live body weight (g) at time T_2 (day)

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Survival rate (%)

The survival rate of each treatment was calculated by counting each species survived at the end of the experiment.

$$\text{Survival rate (\%)} = \frac{\text{No. of fish harvested}}{\text{No. of fish stocked}} \times 100$$

Statistical analysis

Data were compiled into means ± SD to check normality of the data for the determination of the effects of growth and survival profile of the gold fish (*Carassius auratus*) fry in different systems (hapa, cistern and pond). The level of significance was taken as $P \leq 0.05$.

RESULTS AND DISCUSSION

Water quality parameters

The results of the water quality parameters such as temperature (°C), pH, dissolved oxygen (mg/L), nitrite (mg/L), ammonium (mg/L) and alkalinity (mg/L) during the experimental period are presented in Table 1. Temperature recorded during the experimental period was more or less similar in different treatments and varied from 24 to 30°C. The highest temperature (29°C) was recorded in treatment T_1, T_2 and T_3 in October was due to high intensity of sunlight and the lowest temperature (26°C) was recorded in systems in November which might be due to low intensity of sunlight and cool air flow. Azim *et al.* (1995) recorded mean values of temperature 26 °C from a set of ponds and he observed this data is very significant for the production of young fish fry. The pH range in the experimental period was found to vary from 7.40 to 8.25. Most natural water has pH values of 6.5 to 9 (Boyd, 1982). The present finding was within acceptable range required for fish culture 6.5 to 8.5 as suggested by DoF, 1996. In the present study the dissolved oxygen content in water ranged from 5.11 to 6.42 mg/l. Uddin (2002) measured dissolved oxygen to range from 2.2 to 8.8mg/l which is similar to the present study.

Table 1. Water quality parameters under different treatments during the study period.

Treatment	Water temperature (˚C)	pH	Dissolved oxygen (mg/L)	Nitrite (mg/L)	Ammonium (mg/L)	Alkalinity (mg/L)
T_1	27.26 ± 1.41	7.69 ± 0.30	6.22 ± 1.35	0.01-0.03	0-0.03	195.5 ± 9.81
T_2	27.26 ± 1.41	7.69 ± 0.30	6.22 ± 1.35	0.01-0.03	0-0.03	195.5 ± 9.81
T_3	27.26 ± 1.41	7.83 ± 0.29	6.42 ± 1.53	0.01-0.03	0-0.03	229.5 ± 9.81

Nitrite is the highest toxic product of the major inorganic nitrogen compounds. Nitrite is formed primarily as an intermediary in the conversion of ammonia to nitrate, a process known as nitrification. Because it gets converted to the nitrate end product quickly, high nitrite concentrations are not common in aquatic systems. In the present experiment nitrite was found to range from 0.01 to 0.03mg/L in all the treatments which is similar to the findings of Raihan (2010).

In the present study ammonium concentration ranged from 0 to 0.03 mg/L which falls within the limits suggested by Boyd (1998). The findings are also more or less similar to that of Rashid (2008). Alkalinity (mg/l) of the experimental systems varied from 187 to 238 mg/l. Uddin (2002) observed that alkalinity varied from 45 to 180 mg/l in earthen ponds of field laboratory of Bangladesh Agricultural University, Mymensingh. The values are near to the findings of the present study.

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Growth and survival parameters of gold fish fry

Weight gain (g), percent weight gain, specific growth rate (% per day) and survival rate (%) of gold fish in different treatments are presented in Table 2. Limited data exist on growth parameters of ornamental fish including gold fish, although some information is available for carp species. In the present experiment stocking density was same in all the systems per unit of water volume. The results of this experiment showed that, the highest growth rate was achieved in T_3. The average weight gain of individual fish in T_3 (3.50±1.11 g) was higher than T_1 (2.59±0.51 g) and T_2 (1.23±0.17 g). Mean weight gain of common carps ranged from 0.76 to 1.12g in cages found by Rai and Bista (2000), which is lower than the present study. Prithwiraj *et al.* (2008) found that the mean weight gain of the koi carps in the earthen pond ranged from 3.14 g to 9.64 g and this value is higher than the present study. Higher weight gain of koi carp in pond treatment could be attributed to better water quality in that treatment (Jha & Barat, 2005).

Table 2. Growth and survival parameters of gold fish (*Carassius auratus*) fry observed in   different treatments during the study period.

Parameters	Treatments		
	T_1	T_2	T_3
Weight gain (g)	02.59 ± 0.51	01.23 ± 0.17	03.50 ± 1.11
SGR (%/day)	06.39 ± 0.22	05.60 ± 0.15	06.68 ± 0.31
Survival rate (%)	40.00 ± 26.46	74.93 ± 9.20	24.17 ± 8.87

The highest SGR for the gold fish culture was in T_3, indicating that this system of culture gives the better growth of fish than other two systems. In this experiment the SGR values were 6.39, 5.60, 6.68% per day in T_1, T_2 and T_3 respectively. Specific growth rates of 5.60 to 6.70 % per day calculated from this investigation were high compared to those published for the gold fish which were between 0.443 to 0.499% per day (Priestley *et al.*, 2005) and closely related Common Carp (*Cyprinus carpio*) which were between 2.81–2.92% per day (Przybyl and Mazurkiewicz, 2004) and 2.6 % per day for the Indian Major Carp (*Catla catla*) (Murthy and Naik, 2000). These higher growth rates are probably because the gold fish in this study were fed rations to satiation level in order to maximal growth. Additionally, a further explanation for the higher SGR values of these gold fish were related to the good water quality of the culture systems and the food delivered to the fish the whole time of the culture period was very nutritious and were preferable to the fish.

Rema and Gouveia (2005) stated that the high survival and growth rates of goldfish larvae (*Carassius auratus*) were observed in cistern and he also noted that there were no significant differences in total length and total weight among the fishes in his experiment and the growth of goldfish larvae was independent. In this experiment the survival rate of gold fish (*C. auratus*) was recorded 40%, 74.93% and 24.17% in T_1, T_2 and T_3 respectively at the harvesting time. The highest survival rate was obtained from T_2 and lowest survival rate obtained from T_3. In the whole period of the experiment the water quality of all the systems was really good and that's why the survival rate was satisfactory in the cistern and hapa. However the survival rate was really poor in pond, this may be the because of the pond protection from the predator was not so good compared to hapa and cistern. Priestley (2005) reported that with suitable water quality in cisterns and 4-6 times feeding frequency all the fish remained healthy with no mortalities.

From this experiment we found that the growth rate was very high in pond than other two systems however the survival rate was low in pond. Higher survival rate was obtained from the cistern although in this system the growth was low than other two systems. With the proper management, pond system should be the best system for gold fish fry rearing.

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CONCLUSION

Ornamental fish rearing has gained much importance now-a-days and gold fish is one of the most favored species. Ornamental fish hatcheries are comparatively low though the breeding techniques are quite easy. If efficient fry rearing techniques are developed it will be possible to meet the local demand of gold fish and will even pave the path of export in the future. The growth and survival of gold fish fry in three different systems: hapa, cistern and pond were observed in the present study. It was found that pond system was best in terms of growth rate while cistern was best for survival rate. Further research is needed in this area to identify the most suitable rearing technique which will be viable both biologically and economically.

COMPETING INTEREST

The authors declare that they have no competing interests.

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