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Effects of feeding frequency on growth and survival in fry of gold fish, *Carassius auratus* (Hamilton) in outdoor rearing system

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ABSTRACT
The effect of feeding frequency on the growth performance and survival of gold fish *Carassius auratus* fry was investigated in the outdoor rearing condition. A total of 135 gold fish fry of 7 days old (initial weight = 0.17±0.00 g) were stocked at the rate of 15 fry/hapa (90×45×60 cm^3) and reared for 35 days set in a pond adjacent to the Faculty of Fisheries. There were three treatments: T_1 (feeding once daily), T_2 (feeding twice daily) and T_3 (feeding thrice daily) each having three replications with same stocking densities. A commercial diet in powdered form (Mega feed; Spectra Hexa Feeds Ltd) containing 34.11% protein was supplied to the fry in each hapa. Initially, the fry were fed at a rate of 100% of their body weight, then the rate was minimized gradually to 80%, 60%, 40%, and 20% respectively at 7 days interval. At the end of experiment, T_3 showed the best performance in case of final body weight, percent body weight, specific growth rate (SGR) and survival of gold fish fry in outdoor nursing condition. The present study suggested that a higher feeding frequency is needed for aquarium suitable gold fish production in large scale basis that will ultimately popularize the ornamental fish keeping among the enthusiastic people.

Keywords: *Carassius auratus*, feeding Frequency, growth performance, hapa, survival rate.

1. Introduction
Ornamental fish culture is a high demandable profession all over the world. At present, this practice is increasing day by day in our country and used as a symbol of status. There are some common ornamental fishes such as Gold fish (*Carassius auratus*), Guppy (*Poecilia reticulata*), Molly (*Poecilia* spp.), Platy (*Xiphophorous maculatus*), Sword tail (*Xiphophorous helleri*), Zebra fish (*Danio rerio*), Tiger barb (*Puntias tetrazona*), Glass fishes (*Chanda ranga*), and colisa (*Colisa fasciatus*) etc. among them gold fish *C. auratus* is the most widely kept aquarium fish species.
It is a freshwater fish under the family Cyprinidae belongs to order Cypriniformes was one of the earliest fish to be domesticated. *C. auratus* is native to the Eastern and Central Asia, including China, Russia, Korea, and possibly Japan and Taiwan [1] and gains its popularity to the people of the world having its bright color and wonderful movement. There are few established hatcheries in Bangladesh where breeding of *C. auratus* is performed. The small scale *C. auratus* breeders possibly have no or little available scientific information on the fry rearing of this species in our country. Mainly adult fish are preferred for keeping in aquarium for aesthetic purposes. Fry may be reared in a wide variety of systems as jars, ponds, cisterns, and hapas etc as a result, growth and survival of fry may vary among these medium.

2. Materials and Methods
2.1 Collection of broodfish and stocking
The *C. auratus* broods were collected from the Aquarium fish market, Kataban, Dhaka. Upon arrival at Backyard Hatchery Complex, adjacent to the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, Bangladesh acclimatized and kept in a cistern (1.23 m×2.44 m×0.46 m) for 25 days. Each cistern has its individual inlet (provided with gentle shower) and outlet (covered by net) which allowed the renewal and removal of water continuously and there were no recirculating systems for water renewal. Twenty experimental

C. auratus fishes were 1 year aged having standard length 10.4±1.1 cm and weight 48.7±15.2 g while the male and female ratio was 1:1 and reared with the commercial feed provided (as granular form) twice daily, once in the early morning and next at afternoon (9:00 am and 6:00 pm) upto their apparent satiation level.

Water hyacinth at the corner as suspended and two thin wooden plate (1.8 m×0.35 m) at the bottom (positioned by means of bricks) were kept in each cistern to keep the water cool and shelter for the fishes respectively. During the study, water temperature by using a celsius thermometer, pH by a portable digital pH meter (MICRO-TEMP, pH 500) and dissolved oxygen (DO) by a digital DO meter (multi 340 i/set, DO-5509; Germany) were recorded as 25.0±1.5 °C, 7.3±0.1 and 6.5±0.5 ppm respectively.

2.2 Spontaneous spawning and fry collection

A few number of fishes were checked periodically by gently pressing their abdomen to ascertain the ovulation and spermiation. After 25 days intensive feeding trial, all the females were found ovulated and the fish were kept in closed observation to monitor behavioral changes. They bred spontaneously in the cistern. Then fertilized eggs were collected from cistern by a a fine mesh net and placed in a 500 ml plastic beaker partially filled with water from the cistern. The fertilized eggs of *C. auratus* were transferred and spreaded homogeneously in 2 trays (101.6×40.6×12.7 cm^3) and 2 mini circular bowl hatchery (30l) with gentle shower. After hatching, the number of hatchlings were carefully counted and reared for 10 days until stocking into the hapas in the pond.

2.3 Experimental design for fry rearing

The experiment was carried out in nine rectangular hapas (90×45×60 cm^3) of 1 mm meshed net with completely randomized design, subjected to treatments in a pond (1.5 decimals and depth 4.5 ft) using bamboo poles at backyard hatchery of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, Bangladesh for a period of 35 days (18 March to 22 April, 2012). There were three treatments namely T_1 (Feeding once daily), T_2 (Feeding twice daily) and T_3 (Feeding thrice daily) each having three replications with 15 fry/hapa stocking densities (initial fry weight = 0.17 g and length = 0.8 cm). A commercial feed (Mega feed; Spectra Hexa Feeds Ltd) containing 34.11% protein was used according to the body weight of fry in each hapa. The fry were initially fed at a rate of 100% of their body weight, the rate was minimized gradually to 80%, 60%, 40%, and 20% at 7 days interval. The fed was applied daily once at 8.00 am for T_1, twice at 8.00 am and 12.30 pm for T_2 and thrice at 8.00 am, 12.30 pm and 5.00 pm for T_3. The experimental hapas were carefully cleaned at sampling dates. The water quality parameters such as dissolved oxygen, pH, ammonia (NH_4^+), nitrite (NO_2^-), phosphate (PO_4), alkalinity (mg/l) were determined at 10 days interval throughout the experimental period by their respective test kits and temperature by celsius thermometer. A number of 5 fry from each hapa were taken randomly to record length (cm) and weight (mg) by using a measuring scale and digital electronic balance (METTLER PJ 3000) respectively every after 7 days during study period by means of scope net. Sampling was done before application of food to avoid the biasness of weight due to presence of excessive food. The fry were released in the respective hapas carefully so that any fry would not be injured. Further, the final mean length, weight, survival and specific growth rate (SGR), food conversion ratio (FCR) of fry were recorded at the time of harvesting. The following parameters were considered:

(i)	Mean weight gain (g) = Mean final weight – Mean initial weight
(ii)	Percent weight gain (%) = [(Mean final weight – Mean initial weight)/Mean initial weight]×100%
(iii)	Mean length gain (cm) = Mean final length – Mean initial length
(iv)	Percent length gain (%) = [(Mean final length – Mean initial length)/Mean initial length]×100%
(v)	Specific growth rate (%/day) = $[(Log_eW_2 – Log_eW_1) / (T_2 – T_1)]×100\%$
	Where, W_2= Final live body weight (g) at time T_2
	W_1= Initial live body weight (g) at time T_1
(Vi)	Food conversion ratio (FCR) = Feed fed (dry weight) / Live weight gain
(vii)	Survival (%) = Total number of fry harvested / Total number of fry stocked ×100%

2.4 Statistical analysis

For statistical analysis of data, a one-way analysis of variance (ANOVA) was used. Significant results were tested by using Duncan Multiple Range Test (DMRT) to identify significant difference among the means. The statistical data analysis was carried out with the aid of the computer software SPSS version 11.5.

3. Results and Discussion

3.1 Water quality parameters: The mean values of water quality parameters like temperature, dissolved oxygen, pH, alkalinity ammonia, nitrite and phosphate recorded during the fry rearing period are presented in Table 1. Temperature, pH, dissolved oxygen, total alkalinity, available nitrogen and phosphorus were within the optimum range for pond fish culture [2, 3].

3.2 Growth performance evaluation

The growth indices of the fry are presented in and denoted graphically in Fig. 1, Fig. 2, Fig. 3 Fig. 4, Fig. 5, Fig. 6 and Fig. 7 respectively for mean weight gain, percent weight gain, mean length gain, percent length gain, SGR, FCR and survival. Treatment with three times (T_3) feeding per day yielded higher growth (length and weight) than feeding once (T_1), while feeding twice (T_2) daily resulted in an intermediate growth but no significant difference (P>0.05). It might be due

to higher feeding frequency and lower competition for diet consumption and proper feed utilization whilst in T_1 this might be due to wastage and degradation of leftover feed for a longtime as a result the fry were not full bellied at noon or afternoon but starved or half starved for a long time that ultimately suppressed normal growth progression of *C. auratus* fry.

Table 1: Average values of water quality parameters under different treatments throughout the study period (35 days)

Treatment	Temperature (^{0}C)	D O (mg/l)	pH	NH_4^+ (mg/l)	NO_2^- (mg/l)	PO_4 (mg/l)	Alkalinity (mg/l)
T_1	25±2.65	2.37±0.15	7.30±0.22	0.00	0.00	0.00	204±34.00
T_2	21±2.55	2.36±0.12	7.34±0.22	0.00	0.00	0.00	192.67±25.97
T_3	26±2.65	2.34±0.15	7.39±0.20	0.00	0.00	0.00	209.67±35.38

Table 2: Average values of growth parameters under different treatments throughout the study period (35 days)

Parameters	Treatment		
	T_1	T_2	T_3
Mean initial weight (g)	0.17±0.06	0.17±0.06	0.17±0.06
Mean final weight (g)	7.97±0.11	9.16±0.74	10.41±0.72
Mean Weight gain (g)	7.81±0.11	8.99±0.74	10.25±0.72
Percentage weight gain	4732.12±63.66	5450.30±451.05	6209.70±434.34
Mean initial length (cm)	0.8±0.03	0.8±0.03	0.8±0.03
Mean final length (cm)	3.1±0.28	3.9±0.15	4.7±0.20
Percentage length gain	36.30±3.41	40.12±4.1	47.36±3.52
SGR (%/day)	4.18±0.04	4.98±0.23	5.14±0.19
FCR	0.42±0.01	0.39±0.01	0.35±0.03
Survival (%)	64.44±3.85	68.43±7.70	78.11±7.70

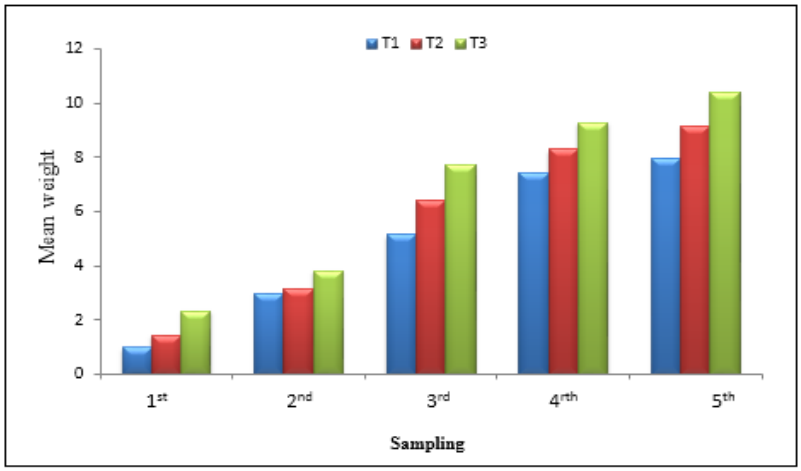

Fig 1: Comparison of the mean weight gain (g) of *C. auratus* fry in different sampling over 35 days.

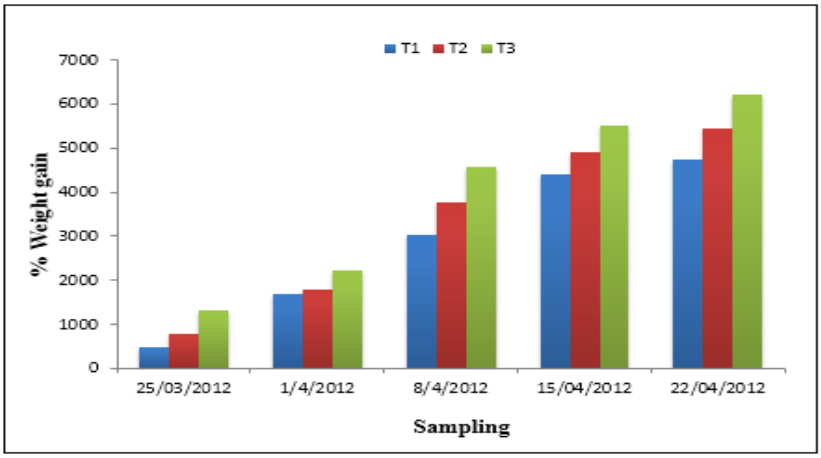

Fig 2: Comparison of the percent weight gain of *C. auratus* fry in different sampling dates over 35 days.

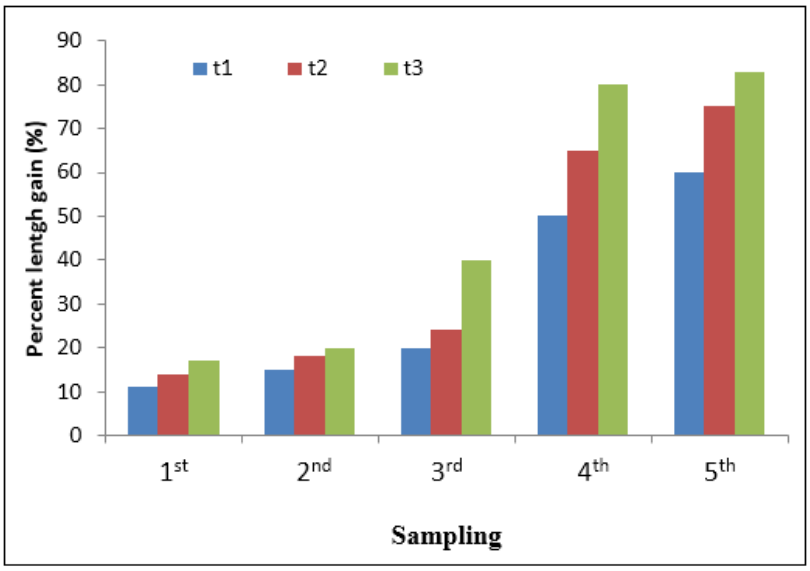

Fig 3: Comparison of the mean length gain of *C. auratus* fry in different sampling dates over 35 days

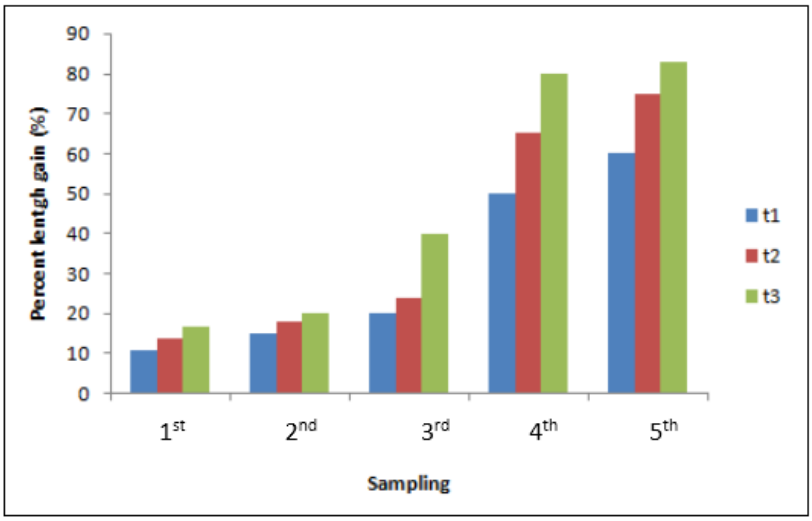

Fig 4: Comparison of the percent length gain of gold fish fry in different sampling dates over 35 days.

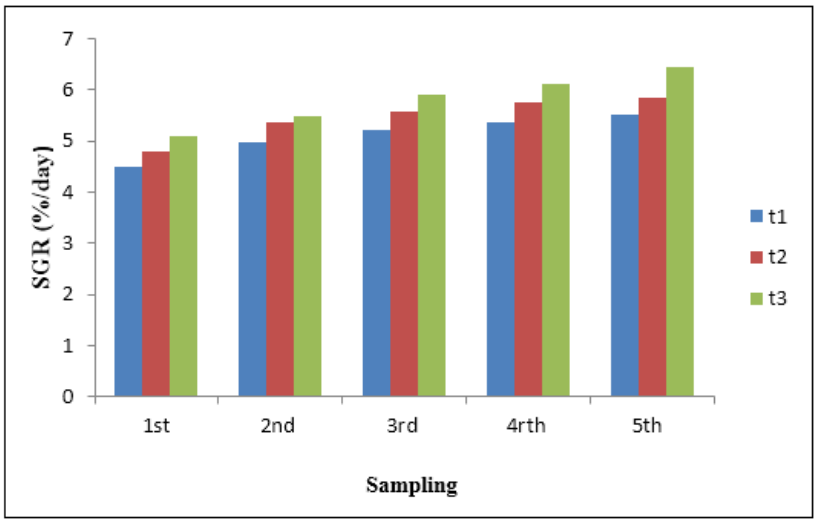

Fig 5: Comparison of the specific growth rate (SGR%/day) of gold fish fry in different sampling dates over 35 days.

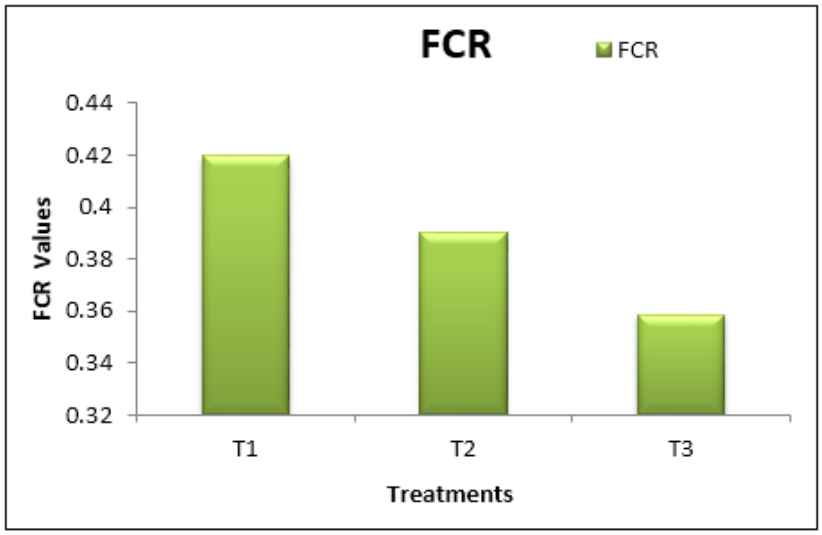

Fig 6: Comparison of the food conversion ratio (FCR) of gold fish fry in different treatments over 35 days

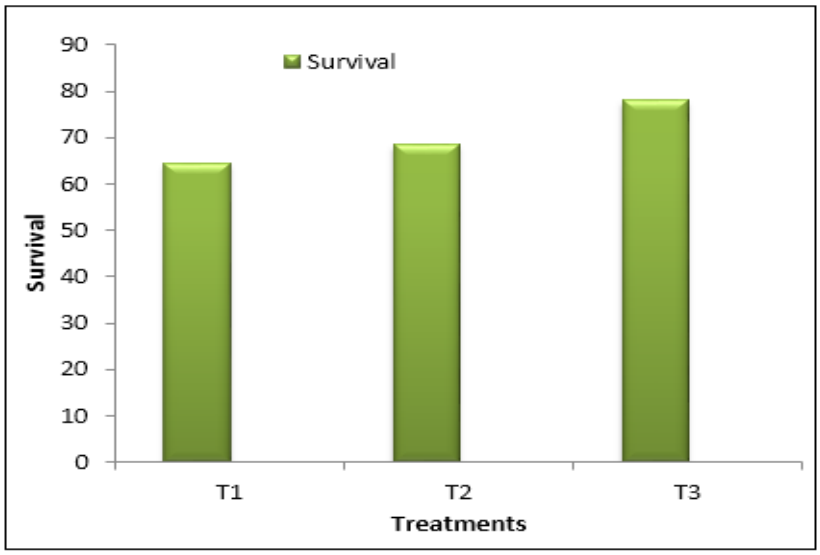

Fig 7: Comparison of the survival rate (%) of gold fish fry in different treatments over 35 days

The present study indicated the requirement of a higher feeding frequency for better performance for *C. auratus*. Improved growth performances of fish with feeding thrice per day were reported by [4] for *Carassius auratus*, [5] in Cyprinus carpio, [6] in *Clarias macrocephalus*, [7] in *Liza parsia* and [8] in *Oncorhynchus mykiss*. In case of Channa *striatus* feeding frequency had no significant effect on the growth of the fish reported by [9].

Comparison of the fish biomass production, though, revealed maximum yield in T_3 with feeding thrice daily followed by feeding twice (T_2) and once (T_1); daily, no significant difference (P>0.05) was recorded among them. The study revealed that feeding frequency did not significantly (P>0.05) influence the survival of *C. auratus* fry. The survival level recorded in T_1 was not significantly (P>0.05) lower than other treatment groups. Similar observations were also reported by [10] working with *Ictalurus punctatus* and [11] in *Heterobranchus bidorsalis*. However, [12, 13, 14] showed that feeding frequency had significant effects on the survival rate of different fish species of *Aristichthys nobilis*, *Epinephelus tauvina* and *Sparus aurata*. In the present study, although feeding thrice daily showed the lowest FCR followed by feeding twice and once daily, no significant difference (P>0.05) was observed among the values, reaffirming the view of [10, 11, 15] who found no significant influence of feeding frequency on FCR in different fish species. Studies carried out with different fish species have shown that the optimum feeding frequency varied with the species, once a day [16, 9]; twice a day [11]; three times a day [5, 7].

4. Conclusion

The present experiment conducted under hapa systems with the contribution of commercial feed, suggested that a higher feeding frequency (3 meals/day) may be advantageous over feeding twice as well as feeding once in *C. auratus* fry rearing. However, other factors viz. water quality parameters, age and size of fish, species, rearing units and ration size can influence the growth performance that can be scrutinized by the frequency of diet application and warrant further investigation.

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