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Short Communication

Effect of different feeds on larval development and survival of ornamental koi carp, *Cyprinus carpio* (Linnaeus, 1758) larvae in laboratory condition

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Abstract

The experiment was conducted for 56-day with a view to observe the effects of different feeds on larval development and survival of 3 day-old ornamental koi carp *Cyprinus carpio* larvae in fiber glass aquaria to develop rearing technique for promoting its aquaculture and for promoting the aquarium business. There were three treatments, each having two replications, stocked with 30 larvae having an initial length and weight of 2.31 ± 0.10 mm and weight of 0.005 ± 0.01 g respectively, in a glass aquaria of size 30 × 10 × 6 inch^3. Three different feeds i.e. crushed pellet feed, mixed diet i.e. 50% pellet + 50% chopped tubificid worms and live chopped tubificid worms, having different protein levels were administered to compare their suitability as food for the rearing of *C. carpio* larvae. The larvae fed with chopped tubificid worms showed significantly better results in terms of length and weight gain, percent length and weight gain and specific growth rate (SGR %) compared to the rest two treatments. The highest survival rate 56.66 ± 2.29% was shown by the chopped tubificid worms fed larvae which was significantly higher than those of crushed pellet feed and mixed diet respectively. Water quality parameters were monitored throughout the experimental periods. On the basis of larval development and survival rate, it could be suggested the live chopped tubificid worms is suitable for the culture of ornamental koi carp *C. carpio* larvae.

Key words: Koi carp, *Cyprinus carpio*, Growth, Survival

Introduction

Keeping ornamental fishes in aquarium has become a common practice, especially in urban areas in Bangladesh. Many aquarium fish species are cultured but ornamental koi carp is one of the best and available fishes in our local market. However these cultures are playing a vital role in the fulfillment of the demand of local aquarists and market demand (Akhter, 1995). Rahman (2005) noted that at least 25 ornamental fish species are available in Bangladesh. The aquarium business has been established as a highly profitable and luxurious business. In recent decades, the market for ornamental fish has grown steadily. The annual global trade value has been estimated to be US $ 9 billion (Swain and Jena, 2002).
The term 'Koi' refers to many strains of ornamental carp that have been genetically selected over many generations (Feldlite and Milstein, 1999). The development of commercial rearing technology of cyprinid fishes is limited mainly by the lack artificial feeds that meet the nutritional requirements of larval and juvenile stages of this fish (Charlon and Bergot 1984, Wolnicki 2005).

Larval rearing is one of the essential criteria for any successful aquaculture. Protein is the basic component of animal tissues, and is therefore, an essential nutrient for both maintenance and growth. The requirements for protein in larval fish are greater than in adult fish and the requirement for essential fatty acids are also greater. These variations occur in the morphology of the digestive organs, the digestive process and the feeding behavior (De Silva and Anderson, 1995). Most of the aquarium culturists and aquarium business entrepreneurs are directly involved in the culture of aquarium fish without taking any especial care and thus subsequently mass mortality occur. Special attention should be taken for larval rearing as this stage is more crucial than those of any stages of life cycle. Protein as well as food is the main source of energy and plays an important role in determining the rate of growth in different life stages (Islam *et al.,* 2004). The present study was carried out to determine the appropriate feed i.e. protein level for larval rearing and survivability of ornamental koi carp *C. carpio* larvae in the closed aquaria. In the hypothesis testing it will be assumed that there is no significant difference on larval development and survival of ornamental koi carp larvae.

Materials and Methods

The experiment was conducted for eight weeks (56 days) from 25th December, 2010 to 20th February, 2011 in the glass aquaria of volume (30 × 10 × 6 inch^3) in the Fish Physiology Laboratory of Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna, Bangladesh. Three treatments were used each having two replications provided with three different feeds i.e. treatment T_1 (crushing pellet feed), treatment T_2 (mixed diet i.e. 50% pellet + 50% chopped tubificid worms) and treatment T_3 (live chopped tubificid worms). Each of the two replications of three treatments was stocked in to 30 larvae having average length of 2.31 ± 0.10 mm and weight of 0.005 ± 0.01 g respectively. The larvae were produced by artificial breeding with PG dose at fish physiology laboratory in Khulna University. The larvae were reared with boiled eggs yolk until the start of the experiment to avoid the biasness of growth. Before stocking of larvae, each of the aquaria was cleaned up and prepared with all the facilities necessary to run the experiment efficiently. About two-third water from each aquarium was replaced with clean water at every alternate day before feeding. Proper aeration was done to supply sufficient oxygen into the aquaria and it continued until the end of research work. The feces in each aquarium were removed by siphoning and the dead larvae were removed and counted in the morning and in the evening prior to feeding. Adhered dirt inside the aquarium walls was cleaned thrice a week. Proximate compositions of feeds were analyzed following the standard methods given by Association of Official Analytical Chemists (AOAC, 1980) in the Fish Nutrition Laboratory of Fisheries and Marine Resource Technology Discipline, Khulna University, Khulna.

The larvae stocked under the different treatments were fed with different feeds administered those three times daily at 700, 330 and 12300 h. Sampling was done at every 7 days interval. Ten larvae were randomly collected from each aquarium to take the length and weight data. The weight (g) was taken in an analytical balance and the length (mm) was measured by placing the fry on a transparent petridish placed on a 1 mm graph-paper. Sampling was done before the application of feed to avoid the biasness of weight due to presence of excessive feed. During the experimental period following water quality parameters were measured e.g. temperature, pH, dissolved oxygen (DO) and alkalinity.

The following formulae were used to determine the different growth parameters

1) Length gain of larvae (mm) = Average final length of larvae – average initial length of larvae.
2) Weight gain of larvae (g) = Average final weight of larvae – average initial weight of larvae.

3) Percent gain in length = × 100

4) Percent gain in weight = $\frac{\text{Average final weight-average initial weight}}{\text{Average initial weight}} \times 100$

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

Where, W_2 = Final live body weight (g) at time T_2
W_1 = Initial live body weight (g) at time T_1

6) The survival rate = $\frac{\text{No. of larvae alive}}{\text{Total number of stocked}} \times 100$

The gain in weight and length, specific growth rate of the fry and survival rate of the larvae were all tested using one-way analysis of variance (ANOVA). Significant results ($P < 0.05$) were further tested using Duncan's Multiple Range Test (DMRT) to identify significant difference between means. This statistical analysis was performed with the aid of the computer software SPSS 12 program.

Results and Discussion

The 56-day long experiment was conducted with a view to observing the effects of different feeds on the growth and survival of the larvae of koi carp *C. carpio*. Proximate composition of feeds were analyzed and given in Table 1. The initial average length and weight of the larvae were 2.31 ± 0.10 mm and 0.005 ± 0.01 g, respectively for all treatments. The final average length of the larvae of treatment T_1 (crushing Pellet feed), T_2 (Mixed diet i.e. 50% pellet feed + 50% chopped tubificid worms) and T_3 (live chopped tubificid worms) were 20.55 ± 3.09 mm, 24.6 ± 2.95 mm and 32.44 ± 1.59 mm while the final average weight were 0.24 ± 0.08 g, 0.30 ± 0.07 g and 0.35 ± 0.03 g, respectively (Table 2).

Table 1. Proximate composition of feeds used for rearing of *C. carpio* for 56 days (% dry weight)

Feeds	Protein (%)	Lipid (%)	Ash (%)
Crushed Pellet feed	30.35	9.66	19.25
Mixed diet (50% pellet feed + 50% chopped tubificid worms)	31.63	8.64	12.85
Chopped tubificid worms	32.78	7.00	10.35

Table 2. Growth performance of koi carp, *C. carpio* larvae of different treatments after 56 days rearing, (mean ± SD)

Parameters	Treatment T_1 (Crushed Pellet feed)	Treatment T_2 (Mixed diet)	Treatment T_3 (Chopped tubificid worms)
Initial length (mm)	2.31 ± 0.10	2.31 ± 0.10	2.31 ± 0.10
Initial weight (g)	0.005 ± 0.01	0.005 ± 0.01	0.005 ± 0.01
Final length (mm)	20.55 ± 3.09^c	24.6 ± 2.95^b	32.44 ± 1.59^a
Final weight (g)	0.24 ± 0.08^c	0.30 ± 0.07^b	0.35 ± 0.03^a
Length gain (mm)	18.24 ± 1.98^c	22.29 ± 2.02^b	30.13 ± 1.89^a
Weight gain (g)	0.235 ± 0.041^c	0.295 ± 0.037^b	0.345 ± 0.025^a
Percent length gain	789.61 ± 5.25^c	964.93 ± 8.62^b	1304.33 ± 7.34^a
Percent weight gain	4700 ± 26.36^c	5900 ± 31.16^b	6900 ± 29.61^a
Specific growth rate	3.29 ± 0.07^c	3.48 ± 0.04^b	3.61 ± 0.06^a
Survival	43.33 ± 2.10^c	53.33 ± 2.25^b	56.66 ± 2.29^a

Values with different superscripts in a row are significantly different (one way ANOVA followed by Duncan test, $P < 0.05$).

The highest length gain was found to be 32.44 ± 1.59 mm in treatment T_3 (fed with chopped tubificid worms) which is significantly ($P < 0.05$) higher than the rest of the treatments. Similarly, the highest gain in weights of the larvae was 0.345 ± 0.025 g in treatment T_3 (fed with live tubificid worms) which is significantly ($P < 0.05$) higher than those of the other two treatments followed by 0.235 ± 0.041 g in treatment T_1 (fed with crushed pellet feed) and 0.295 ± 0.037 g in treatment T_2 (fed with mixed diet). The highest percent length gain was 1304.33 ± 7.34% and percent weight gain was 6900 ± 29.61%, respectively as observed in the larvae fed with live tubificid worms (Table 2). After completion of the experiment, the highest specific growth rate was found to be 3.61 ± 0.06% shown by the larvae fed chopped tubificid worms (Table 2) which was significantly ($P < 0.05$) higher compared to those in treatment T_1 and T_2. The survival rates were found to be 56.66 ± 2.29%, 53.33 ± 2.25% and 43.33 ± 2.10%, respectively in T_3, T_2, and T_1 (Table 2).

Ornamental koi carp *C. carpio* is a fast growing species well suited to farming in ponds and lakes (Hashem *et al.,* 1997). According to Al-Hafedh (1999) growth rate of fish increases with increase in the level of dietary protein till the optimum level is reached. Jana and Chakrabarti (1993) suggest that growth, reproductive potentials, and survival of each species are affected by the nutrient conditions of the culture media. In the present study the experiment was conducted in closed condition in the aquaria that were different than any natural environment. Hashem *et al.* (1997) conducted an experiment on *Cyprinus carpio* using different food ingredient having a protein level of about 25% for all feed in floating pellets. They concluded that optimum weight and length of 24.52 g and 8.07 cm, respectively for six months rearing against the initial weight and length were 5.94 g and 3.76 cm, respectively. The variation may be due to experimental period because they conducted the experiment for six months and the present study was limited within 56 days. In the present experiment, the average length of 32.44 ± 1.59 mm is comparatively lower than of the findings of Hashem *et al.* (1997). Another possible cause is the mode of operation. They conducted the experiment in pond where the fish got natural feed with supplemental feed. It helped them to get better growth. On the contrary, the present study was conducted in aquarium using supply water lacking natural nutrient in water and the time of winter season. Cyprinid larvae are known to prefer natural food items such as free living protozoa and rotifers, and larger planktonic organisms like cladocerans and copepods at fry and fingerling stage (Jhingran and Pullin, 1985). Live-food has been the most useful feed for rearing of fry of *Coregonus lavaretus* (Mahmoudzadeh, 2009). It also plays an important role in the shrimp and salmon industry. Among the different live-foods e.g. rotifers, *Brachionus* spp., *Moina* sp., *Artemia* sp. etc. tubificid worms are very popular and cheap live-food used for feeding larvae of carnivorous and omnivorous fish species (Bucher, 1977). Considerably better growth and survival rates of larvae and fry were observed with tubificid worms over formulated feeds in a number of catfish species such as *Clarias batrachus* (Alam and Mollah, 1988; Mollah and Nurullah, 1988), *Clarias macrocephalus* (Mollah and Tan, 1982), *Clarias lazera* (Hogendoorn, 1980), *Heteropneustes fossilis* (Haque and Barua, 1987). The results of the present experiment also suggest the suitability of live chopped tubificid worms as food of *C. carpio* larvae.

Stocking density is known as one of the important parameters in fish culture, since it directly affects growth and survival, and hence production (Backiel and Lecren, 1978). Hecht and Appelbaum (1987) conducted an experiment with the larvae and juveniles of *Clarias gariepinus* and concluded that growth and survival was density dependant and that live food was preferred to formulated feed. In this experiment the stocking density was 30 larvae in each aquarium that was an acceptable density in respect of previous research works.

The feeding frequency of 3 times/day was adopted during the present experiment to avoid water fouling and ease of feed provision and other managements. Feeding frequency has direct impact on the growth performance and survival of fry and larvae of *Clarias macrocephalus* (Mollah and Tan, 1982). They found that a feeding frequency of three times in each day was best for rearing the fry and larvae of *Clarais macrocephalus* which is relevant to the present study.

The common carp is a hardy fish, and koi retains that durability. Koi are cold-water fish, but benefit from being kept in the 15-25°C range, and do not react well to long, cold, winter temperatures; their immune systems "turn off" below 10°C. The available information suggests that the survival rate is very poor in earlier stage of their life cycle. In treatment T_1 the survival rate was lower than these of other two treatments because, pellet feed was used in treatment T_1 which deteriorated the water quality much than other two treatments. This result may be due to poor physiological development of earlier stage of life. Beside this ornamental fish in captivity need to utilize their dietary protein with the utmost efficiency, as the breakdown products of protein metabolism mainly ammonia will directly pollute their living environment (Debnath *et al.,* 2005).

Conclusion

Aquarium business entrepreneurs in Bangladesh are involved mainly in variety of carp species culture. Business entrepreneurs are lacking the knowledge about the rearing and feeding of the ornamental koi carp. The results of the current experiment may be of some help for commercial aquarium business entrepreneurs.

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