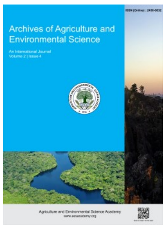
Archives of Agriculture and Environmental Science 8(3): 364-369 (2023)
https://doi.org/10.26832/24566632.2023.0803014

e-ISSN: 2456-6632

This content is available online at AESA

Archives of Agriculture and Environmental Science

Journal homepage: journals.aesacademy.org/index.php/aaes



ORIGINAL RESEARCH ARTICLE

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Domestication performance of the striped snakehead *Channa striata* fry in pond conditions using different diets

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ARTICLE HISTORY

Received: 25 June 2023
Revised received: 21 August 2023
Accepted: 6 September 2023

Keywords

C. striata
Domestication
Feeding rate
Growth
Survivality

ABSTRACT

The experiment was conducted to assess the performance of growth, rate of survival and FCR of the different feed types in *Channa striata* fry at the freshwater station of the Bangladesh Fisheries Research Institute. The experiment *was* undertaken with *3 treatments* (T_1, T_2, and T_3) and *each* having three *replications* (R_1, R_2, and R_3). Each treatment included the provision of three different feed types, with a stocking density of 1,00,000 individuals per hectare. Fry in T_1 was fed a commercial feed that contained 40–35% protein at 40–10% of total body weight. In T_2, 40–10% of the body weight of commercial feed, which included fish paste, was given. Contrarily, in T_3 live fish fry and chopped fish were provided at 30–10% of total body weight. The mean weight gains in T_1, T_2, and T_3 were 128.7, 140.7, and 162.3g, respectively with percentage weight gains were 81279, 87867, and 100999 respectively, as well as SGR, were 3.34%, 3.37%, and 3.45%, respectively. T_1 revealed the lowest amount of weight gain, weight gain percent and SGR, whereas T_3 revealed the highest. The mean survival rates at T_1, T_2, and T_3, respectively, were 45.5%, 71.8%, and 82.67%, whereas the FCR values were 2.26, 2.05, and 1.79. T_1 had the lowest survival rate and FCR values, while T_3 showed the highest. These experiment findings revealed that chopped fish and live fish fry had a more optimistic effect on the survival and growth of the *C. striata* fry compared with other commercial feeds.

Citation of this article: Awal, M. R., Islam, M. S., Khanom, M., Bhadra, A., & Mahmud, Y. (2023). Domestication performance of the striped snakehead Channa striata fry in pond conditions using different diets. *Archives of Agriculture and Environmental Science*, *8*(3), 364-369, https://dx.doi.org/10.26832/24566632.2023.0803014

INTRODUCTION

The fastest-growing sector of food production globally is aquaculture, which is important to both nutrition and food security (Kumari *et al*., 2018). Bangladesh is fortunate for having an abundance of water resources that are large and dispersed over the country in the form of ponds, lakes, beels, canals, small and large rivers, and estuaries, that extend over an area of around 3.34 million hectares (Mazid, 2002). The majority of Bangladeshi consumers' fish comes from small native fish species, which can grow to a maximum size of 25 cm when they are mature or adults (Rana *et al*., 2020). Along with other species of the genus *Channa*, *C. striata*, also referred to locally as "Shol," accounts for 4.2% of all fish produced in Bangladesh and is an economically significant species (Mollah *et al*., 2009). There are 92523 tonnes of striped murals produced globally, with aquaculture contributing 21721 tonnes and catch fisheries contributing 70802 tonnes respectively (FAO, 2016). It could flourish in aquaculture and turn into a valuable species and product (Purnamawati *et al*., 2017). There is an incredibly high demand for food fish in the market because of its high nutritive value (Ahsan *et al*., 2015). The species is widespread in Western to Southeast Asian countries, including Bangladesh, India, China, Cambodia, Indonesia, Myanmar, Lao People's Democratic Republic, Malaysia, Pakistan, Nepal, Sri Lanka, Vietnam, and Thailand (Rawat *et al*., 2021). They are endemic fish that are vital to freshwater ecosystems in tropical Africa and Asia (Munafi *et al*., 2004). Attributed to the reason that *C. striata* have an air-breathing organ, it is unaffected by poor water quality and can therefore obtain oxygen from the environment, but it is still susceptible to abrupt environmental changes. It has attributes which thus make it a valuable species for culture, such as its high market rate, growth, resistance to high-density stocking, and the ability to use atmospheric oxygen to live in low-oxygen environments (Sampath, 1984). Domestication is the first stage in maintaining snakeheads in their native environment and developing their culture (Syamsunarno & Sunarno, 2022). The farming of *C. striata* is still not widespread in Bangladesh in pond habitats either monoculture or polyculture systems. In Bangladesh, the production of this species is steadily declining as a result of the degradation of the feeding, breeding, especially nursery grounds. Early research concentrated on Artemia nauplius and formulated feed for the production and survival of larval snakeheads (Qin *et al.*, 1997). Snakeheads are fed as trash fish, wheat flour, rice bran, vitamins, and minerals by Thai farmers (Boonyaratpalin *et al.*, 1985). As a result, the main objective of this experiment is to evaluate the impact of different feed types on the growth and well-being of *C. striata* fry.

MATERIALS AND METHODS

Experimental site and period

The experiment was performed for 180 days in the ponds at the Freshwater Station of the Bangladesh Fisheries Research Institute, Bangladesh. The study region is located at latitudes 24.7214° N in the north and 90.4212° E in the east.

Description of the experimental units

The experiment was conducted at the freshwater station of the Bangladesh Fisheries Research Institute in Mymensingh using three earthen ponds. Each pond was 10 decimals in size, and they were all identical in terms of their depth, shape, size, and whether or not they had any water features. It was kept at a maximum water depth of 1.2 meters. To keep the water level constant, a well-designed outlet and inlet system were set up. The pond received its water from the deep tube well. Each pond was split into three equal halves because there was no other pond facility that could be used to replicate the whole treatment. Using bamboo fencing and glass nylon net, ponds were separated.

Experimental design

The experiment included three different treatments (T_1, T_2, and T_3) and each with three replications. Every treatment has a stocking density of 100000 individuals per hectare. Three different types of feed were applied for each treatment. At 40–10% of total body weight, commercial feed (protein 45–35%) was given in T_1. In T_2, a commercial diet that included fish paste was supplied at a rate of 40–10% of the body weight. Live fish fry and chopped fish were applied in T_3 at 30–10% of total body weight twice daily. The experimental strategy is displayed in (Table 1).

Pond preparation

The ponds were appropriately sun-dried before stocking the *C. striata* fry. Aquatic plants and undesirable fish were completely removed manually. The ponds were prepared with lime and fertilizer. Per hectare, 250 kg of lime was used. 25 kg ha^{-1} of urea and 25 kg ha^{-1} of TSP were used, respectively, to produce plankton and algae. When the water turned green, three ponds were stocked with fish fry following the experimental design, which was implemented three days after fertilizer application. Aquatic weeds (Kalmilota and Water hyacinth) were accustomed to creating shelter for *C. striata* fry. Hereafter, the ponds were subsequently enclosed using bamboo sticks and nylon nets.

Collection and stocking of fry

Haor in the districts of Netrokana and Kishoriganj was used to collect *C. striata* fry for research purposes. To protect their health and safety, fry was transferred to the hatchery in oxy-polythene bags and also plastic containers. To aid in their acclimatization, the fry was kept in a cistern for 5–6 hours after collection. After acclimating, the fry was transferred to the experimental ponds. Fry was measured and recorded for their first mean length (cm) and weight before being stocked into the ponds (g)

Feed and feeding

Fish muscle paste, live fish fry, and readily available commercial feed were applied for the current experiment. At the start of the experiment, the feed was provided at 40% of body weight, and it was progressively decreased to 10% of body weight. In addition to feeding, 100g TSP and 75g urea were applied twice every two weeks to the water to increase its primary productivity (Zooplankton).

Measurement of physico-chemical parameters

Every two weeks intervals at 9:00 am the water quality parameters of the experimental ponds including water temperature, pH, DO, ammonium, and alkalinity were assessed. Samples were taken at each biweekly interval to further evaluate the fry's performance in terms of survival and growth.

Table 1. *Experimental layout of C. striata fry using different kinds of feed.*

Treatments	Replications	Feed	Stocking density (nos./ hector)	Culture periods
T_1	03	Commercial feed at 40-10% BW	100000	180 days
T_2		Commercial feed mixed with fish paste at 40-10% BW		
T_3		Live fish fry and chopped fish at 30-10% BW		

Sampling procedure and parameters study

After 15 days, ten to fifteen fries from every treatment were selected randomly and measured. Weight was determined using an analytical balance (g), and length was determined using a scale (cm). To avoid weight biases caused by feed still being in the intestines, sampling was carried out following a brief fast. The overall number of fish in every treatment was recorded at the end of the trial, and a precise formula was used to calculate the percentage of survival. The data on fish growth that was measured and noted were calculated using the procedure below:

$$\text{Length gain (cm)} = \text{Average final length (cm)} - \text{Average initial length (cm)}$$

$$\text{Weight gain (g)} = \text{Mean final weight (g)} - \text{Mean initial weight (g)}$$

$$\text{SGR (\%bw/d)} = \frac{(\ln \text{final weight} - \ln \text{initial weight})}{\text{culture period in days}} \times 100$$

$$\text{Survival rate (\%)} = \frac{\text{Final population (individual)}}{\text{Initial population (individual)}} \times 100$$

$$\text{FCR} = \frac{\text{Amount of feed (g)}}{(\text{Final biomass (g)} + \text{Deceased fish biomass (g)}) - \text{Initial biomass (g)}}$$

Statistical analysis

A one-way analysis of variance (ANOVA) at the 95% level of confidence was performed to see if the statistically significant impact. The water quality parameter, graphs, and descriptive analysis (length and weight growth) were completed using Microsoft Excel 2016 and SPSS version 25.

RESULTS AND DISCUSSION

The experimental fishes were harvested after 180 days of cultivation. There is no doubt that feed had an effect on the final weight, production, survival, and FCR in the current experiment. The results of the current experiment, including those related to weight gain, weight gain percentage, specific growth rate, survival rate, FCR, and water quality parameters, are discussed below and contrasted with those of other researchers working in the field. Every two weeks interval during the experiment, assessments of the water parameters including temperature (°C), pH, DO, ammonia, and total alkalinity (mg/l) were made. The water quality variables were tested and are shown in Table (2). The temperatures of the water were generally constant during the trial period. The water temperature ranged from 22.21 to 31.41°C in T_1, 22.8 to 30.41°C in T_2 and 22.2 to 30.54°C in T_3. T_2 had the lowest mean water temperature of 26.93°C while T_1 had the highest water temperature of 27.39°C (Table 2). Among treatments, there were no noticeable differences ($p>0.05$) in temperature. Water quality is important because it directly affects the overall health of cultured fish. Because temperature has a big impact on metabolic activity, fish metabolism needs to be regulated at the right temperature (Kumari *et al.*, 2018). Fish growth would be inhibited and possibly result in fish death if water quality parameters like DO, temperature, ammonia, alkalinity, and pH were above the optimum and tolerance ranges (Purnamawati *et al.*, 2017). Water temperatures between 25 and 35 degrees Celsius are suitable for fish culture, according to Aminul (1996), and between 25.5 and 30 degrees Celsius, according to Akhteruzzaman (1988). The water temperature in this experiment was found to be within the ideal range

Table 2. Average values of the water parameters during the experiment.

Parameters	Treatments			Suitable range
	T_1	T_2	T_3	
Water temperature (°C)	27.39±0.83[a] (22.21-31.41)	26.93±0.58[a] (22.8-30.41)	27.3±0.61[a] (22.2-30.54)	26-31°C
pH	7.99±.07[a] (7.5-8.76)	7.69±.09[a] (6.31-8.22)	7.78±.07[a] (6.5-8.3)	6.5-8.5
Dissolved Oxygen (DO) (mg/L)	5.09±0.12[b] (3.6-6.29)	5.18±.13[ab] (3.32-5.79)	5.32±.65[a] (3.15-5.8)	4-7mg/L
Total Alkalinity (mg/L)	118.3±1.31[a] (110-130)	116.7±1.52[a] (100-130)	117.6±1.7[a] (110-130)	70-190mg/L
NH_3 (mg/L)	0.027±.008[b] (0.001-0.11)	0.016±0.005[a] (0.001-0.09)	0.022±0.006[ab] (0.002-0.10)	0.0-0.04mg/L

Table 3. Growth performance of *C. striata* fry under different treatments.

Parameters	Treatments		
	T_1	T_2	T_3
Initial mean weight (g)	0.161±0.001[a]	0.162±0.001[a]	0.162±0.001[a]
Initial mean length (cm)	2.83±0.01[a]	2.84±0.01[a]	2.83±0.01[a]
Final mean weight (g)	128.9±3.15[c]	140.9±4.25[b]	162.5±4.65[a]
Final mean length (cm)	26.16±2.12	26.76±2.96	27.66±3.12
Av. daily weight gain (g)	0.64±0.01[c]	0.70±0.02[b]	0.81±0.03[a]
Weight gain	128.7±2.44[c]	140.7±3.39[b]	162.3±4.21[a]
Weight gain (%)	81279±439[b]	87867±467[ab]	100999±952[a]
SGR (%day)	3.34±0.02[c]	3.37±0.01[ab]	3.45±0.02[a]
FCR	2.26±0.04[c]	2.05±0.035[b]	1.79±0.028[a]
Survival (%)	45.5±3.04[c]	71.8±3.51[b]	82.67±4.14[a]

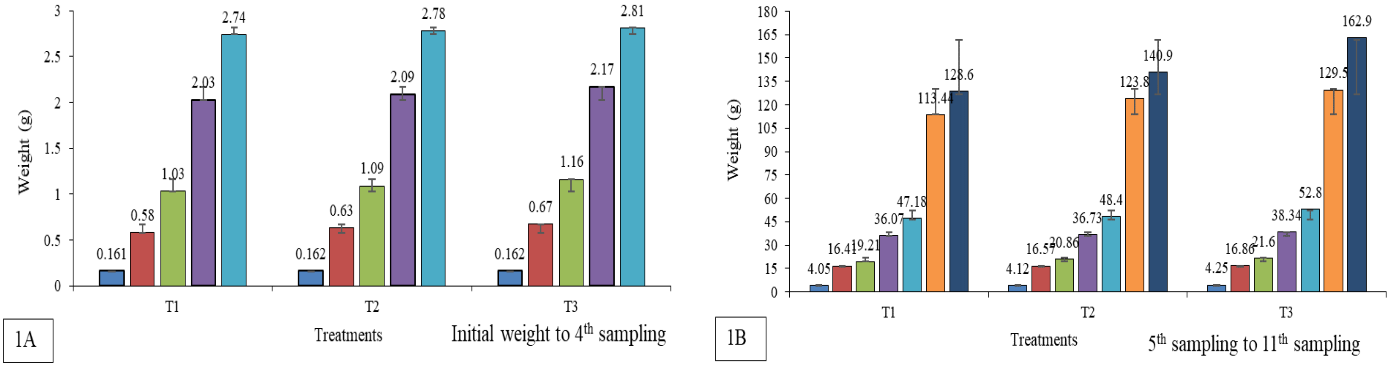

Figure 1. *A) and B) Bi-weekly variation in growth of C. striata fry under different treatments.*

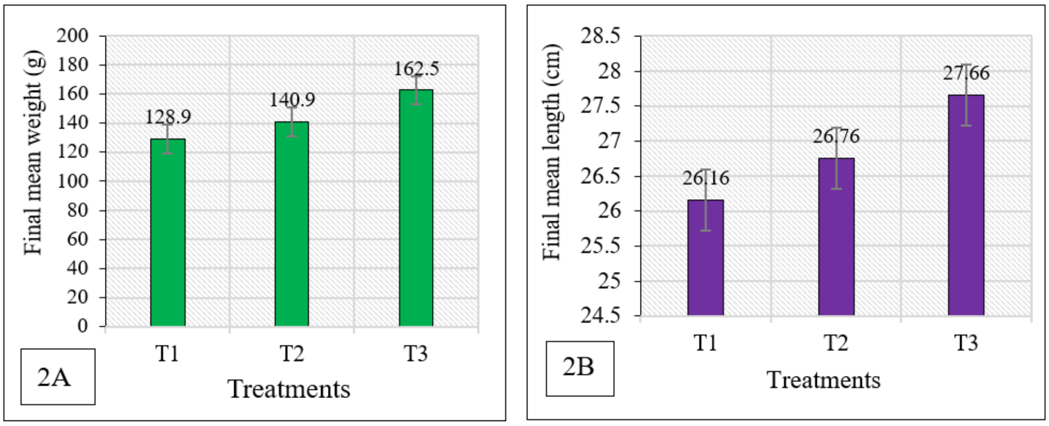

Figure 2. A) *Final mean weight (g) B) Final mean length (cm) of C. striata fry.*

needed for aquaculture in all treatments, and the results were in good agreement with those of Haylor and Mollah (1995) and Rahman *et al.* (2005) for the rearing of *C. striata* fingerlings. There was no discernible difference (p>0.05) in dissolved oxygen among the treatments. The dissolved oxygen levels in T_1, T_2, and T_3 varied from 3.6 to 6.29 ppm, 3.32 to 5.79 ppm, and 3.15 to 5.8 ppm, respectively (Table 2). The highest value of dissolved oxygen was found 5.32 ppm in T_3 whereas T_1 had the lowest mean value 5.09 ppm. The pH values ranged from 6.5 to 8.3, 7.5 to 8.76, and 6.31 to 8.22 in T_1, T_2, and T_3, respectively. T_1 had a pH value of 7.99 while T_2 had a pH value of 7.69, with 7.69 being the lowest and 7.99 being the highest, respectively (Table 2). The rate at which fish and other aquatic organisms utilise oxygen could vary, photosynthetic activity could change with the monsoon's cloudy and sunny weather, and dissolved oxygen concentrations might fluctuate for a variety of reasons (Boyd, 1982). Dissolved oxygen was found to be between 6.2 and 7.1 mg/l during the experiment according to Kumari *et al.* (2018). The snakehead fish has a respiratory organ called diverticula, so this fish can live in oxygen-depleted water and utilise oxygen in the air, so when the average dissolved oxygen level is less than 5 mg/L, it will not cause death if it does not occur for a long time, according to Effendi *et al.* (2012). The snakehead fish belongs to the group of fish that breathe air, so even though it is taken out of the treatment medium for anywhere between a few minutes and several hours, the fish is still alive. The pH values did not significantly change (p>0.05) throughout the experiment. According to the results, total alkalinity levels in T_1, T_2, and T_3 were 110 to 130 mg/L, 100 to 130 mg/L, and 110 to 130 mg/L, respectively. T_1 had the highest mean value of 118.3 mg/L while T_2 had the lowest mean value of 116.7 mg/L (Table 2). A water body's productivity is measured using its pH, which is regarded as a key factor in fish culture. The pH ranges that are ideal for pond fish culture are 6.5 to 8.5. During the period of the experiment, the pH value was found to be within a suitable range and stayed in the alkaline range. When comparing the treatments, the total alkalinity values did not differ significantly (p>0.05). The current experiment's alkalinity levels show that pond productivity was between moderate and high. According to the findings, the concentrations of NH_3-N in T_1, T_2, and T_3 were, respectively, 0.001 to 0.11, 0.001 to 0.09, and 0.002 to 0.10 mg/L. T_1 had the maximum average value of 0.027 mg/L whereas T_2 had the lowermost average value of 0.016 mg/L (Table 2). The experiment's ammonia-nitrogen content level does not endanger the fish's health. Additionally, the results of the current experiment showed that all of the treatments' water parameters were suitable for fish growth. Bi-weekly variation in growth of *C. striata* fry under different treatments were displayed in Figures 1A and 1B. The initial average weight (g) and length (cm) of *C. striata* fry were 0.161 0.01g and 2.84 0.01cm, 0.162 0.01g and 2.83 0.01cm, and 0.162 0.01g and 2.84 0.01cm, respectively, in T_1, T_2, and T_3 (Table. 3). The final mean weights of *C. striata* in T_1, T_2, and T_3 were 128.93.15g, 140.94.25g, and 162.54.65g, respectively (Figure 2A). The final mean lengths were 26.16 2.12 cm, 26.76 2.96 cm, and 27.66 3.12 cm, respectively (Figure 2B). This result compares favourably to that of Rawat *et al.* (2021), who cultured *C. striata* fingerlings for 330 days and found that their weight was 202g.

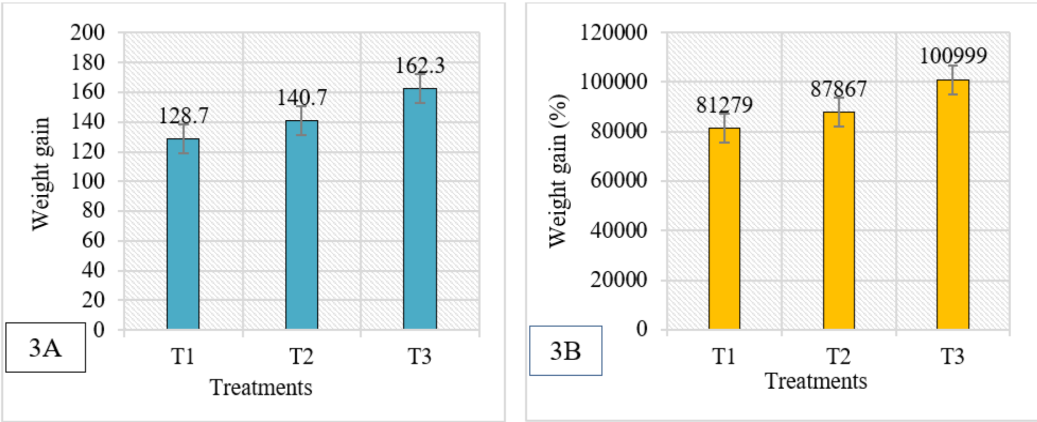

Figure 3. *A) weight gain, B) Weight gain (%) of C. striata in three different treatments.*

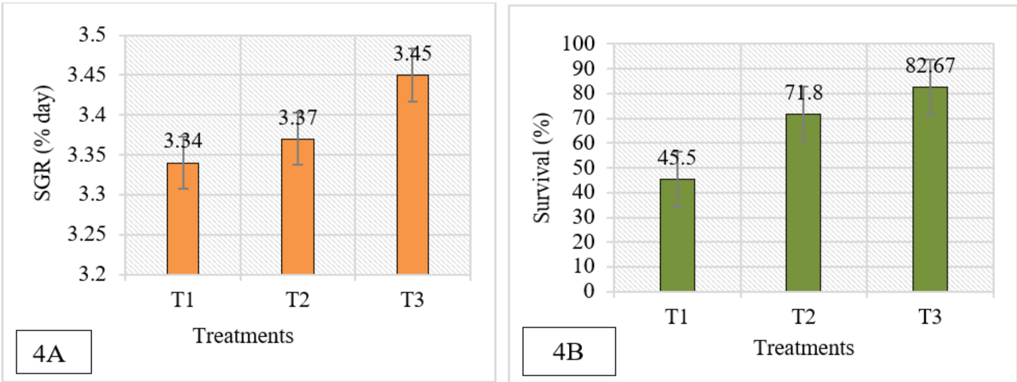

Figure 4. *A) SGR (% day) B) Survival rate (%) of C. striata in three different treatments.*

When *C. striata* were cultured for 220 days using only live fish fry, Farhana *et al.* (2016) noticed that the final weight of the fish was approximately 400g. The findings of Rawat *et al.* (2021) and Farhana *et al.* (2016) revealed a slight variation in fish weight, which may be attributed to factors such as the feed's quality, the environment in which the fish are reared, their density, the duration of the culture, the seed sources, etc. The growth performance under different treatments is presented in terms of weight gain and weight gain percentage. The weight gain and percentage of weight gain 128.7±2.44 and 81279±439 in T_1, 140.7±3.39 and 87867±467 in T_2, and 162.3±4.21 and 100999±952 in T_3 were found (Figures 3A and 3B). ANOVA analysis of the data revealed that, compared to the T_1 and T_2 treatments, the fry from the T_3 group gained more weight and did so at a significantly higher ($p<0.05$) percent growth rate. T_1 and T_2 results were practically identical ($p>0.05$). Therefore, live fish fry and fish paste are good options economically to develop *C. striata* for successful and sustainable aquaculture. Regarding *C. striata* fingerlings Rawat *et al.* (2021) reported similar findings, which experienced a weight gain of almost 200g. When *C. striata* were cultured for 220 days only using live fish fry, Farhana *et al.* (2016) observed that the weight gain was about 355g. Due to variations in initial weight and stocking density of *C. striata* fry, some variation in weight gain was noted in Farhana *et al.* (2016) findings. Among treatments, there was a significant difference ($p<0.05$) in the SGR. The mean SGR for *C. striata* fry is shown in Table (3). Mean specific growth rates of the fry were found to be 3.34±0.02, 3.37±0.01 and 3.45±0.02, respectively, in T_1, T_2, and T_3 (Figure 4A). The mean SGR of *C. striata* fry increased over the period of the experiment. The consumption of live fish fry and chopped fish for growth may have contributed to the higher SGR values in this experiment. The results of Rawat *et al.* (2021) are not comparable to this finding. The average specific growth rate for *C. striata* fingerlings, according to Rawat *et al.* (2021), was 0.58, whereas the highest mean specific growth rate in our experiment was 3.45. When stocking density was 40 per decimal, Farhana *et al.* (2016) found a specific growth rate of 7.88 from April to October. This variation may result from differences in the environment, stocking density, feed, availability of nutrients, water temperature, disease, and other factors that affect fish growth. The survival rates in T_1, T_2, and T_3 were found to be 45.5±3.04, 71.8±3.51, and 82.67±4.14, respectively after 180 days of the trial period (Table 3). Among the treatments, there were significant differences in the survival rates ($p<0.05$). The survival rate was higher when chopped fish muscle and live fish fry were used. But the use of commercial feed was associated with lower survival rates (Figure 4B). For *C. striata* fingerlings, Rawat *et al.* (2021) reported somewhat similar findings. The highest survival rate, 85%, was found by Rawat *et al.* (2021) in a subtropical climate with temperatures ranging from 15 to 29°C. Contrary to our findings, Farhana *et al.* (2016) found a survival rate of 97. Fish survival is influenced by several variables, including stocking density, feed nutrient quality, water temperature, fish disease, and other factors. The highest survival rate, 91%, was noticed by Kumari *et al.* (2018) in *C. striata* fingerlings, which is roughly consistent with our findings. This suggests that feed has a significant direct impact on *C. striata* survival.

The FCR was found to be 2.26±0.04, 2.05±0.35, and 1.79±0.02 after the period of the experiment as per T_1, T_2, and T_3. FCR differed significantly among treatments ($p<0.05$). When live fish fry and chopped fish were applied, the FCR was lower (1.79). Nonetheless, supplying commercial feed resulted in a higher FCR value (2.26). Once live fish were used to fry in *C. striata*, Farhana *et al.* (2016) found an FCR of 1.56 that was relatively similar to our results. Snakeheads with an FCR value of 1.0 were fed a formulated feed at 5% body weight (Qin and Fast, 2003). For *C. striata* fingerlings, Kumari *et al.* (2018) observed an FCR of 2.10. The current experiment found that the major growth period only lasted for about four to five months, with poor growth occurring during the winter because of the winter season. The consumption of rations up to 30–10% of body weight per day by fingerlings, who prefer live fish as their main source of nutrition, indicates that trash fish is the only type of feed that will adequately increase growth rate and ensure survival.

Conclusion

In conclusion, it is suggested that, as compared to other diets, live fish fry as well as trash fish provide good nutrition for *C. striata* fry. It is predicted that this evidence would provide insightful data for *C. striata* production in Bangladesh.

Conflict of Interest

Authors have no conflicts of interest.

ACKNOWLEDGEMENTS

The researchers would like to convey their appreciation and gratitude to Bangladesh Fisheries Research Institute for providing the resources and funding that were required for the project and allowing them to successfully carry out this important research at Freshwater Station, Mymensingh.

REFERENCES

Ahsan, M. E., Rahman, M. L., Salam, M. A., & Akter, T. (2015). Culture System Development of Shol; *Channa striata* in Captive Condition with Indian Major Carps. *World Journal of Fish and Marine Sciences, 7*(5), 404-410.

Akhteruzzaman, M. (1988). A study on the production of koi fish (*Anabas testudineus*) under a semi-intensive culture system. *Bangladesh Journal of Zoology*, 3, 39-43.

Aminul, I.M. (1996). Qualities of water and soil in Aquaculture. Fish week Compendium. Department of Fisheries Publication, Ramona, Dhaka -1000.

Boonyaratpalin, M., McCoy, E.W., & Chittapalapong, T. (1985). Snakehead Culture and its Socio-Economics in Thailand. Annual Report, Fisheries and Aquaculture Department, Thailand.

Boyd, C. E. (1982). Water quality management for pond fish culture. Elsevier Science Publishers, Netherlands Pages, 318.

Effendi, H., Adiwilaga, E.M., & Sinuhaji, A. (2012). Pengaruh pencampuran air terhadap oksigen terlarut di sekitar karamba jaring apung, waduk Cirata, Purwakarta, Jawa Barat. *Jurnal Ecolab*, 6, 1–60.

FAO, (2016). Species fact sheet *Channa striatus* (Bloch, 1793). Fisheries and Aquaculture Department, Food and Agriculture Organisation of the United Nations, Rome, Italy.

Farhana, T., Hasan, M. E., Mamun, A., & Islam, M.S. (2016). Commercially Culture Potentiality of Striped Snakehead Fish *Channa striatus* (Bloch, 1793) In Earthen Ponds of Bangladesh. *International Journal of Pure and Applied Zoology*, 4, 2, 168-173.

Haylor, G. S., & Mollah, M. F. A. (1995). Controlled hatchery production of African catfish, Clarias gariepinus: the influence of temperature on early development, *Aquatic Living Resources*, *8*, 431-438.

Kumari, S., Tiwari, V.K., Rani, A. M. B., Kumar, R., & Prakash, S. (2018). Effect of feeding rate on growth, survival and cannibalism in striped snakehead, *Channa striata* (bloch, 1793) fingerlings. *Journal of Experimental Zoology India*, *21*(1), 205-210.

Mazid, M. A. (2002). Development of Fisheries in Bangladesh; plan and strategies for Income Generation and Poverty Alleviation. p. 310.

Mollah, M. F. A., Mamun, M.S.A., Sarowar, M.N., & Roy, A., (2009). Effects of stocking density on the growth and breeding performance of brood fish and larval growth and survival of shol, *Channa striatus* (Bloch). *Journal of Bangladesh Agricultural* University, 7(2), 427–432

Munafi, A. B. A., Tarn, B. M., Ambak, M. A., & Ismail, P. (2004). Effect of different diets on growth and survival rates of snakehead (*channa striata* bloch, 1797) larvae. *Korean Journal of Biological Sciences*, *8*(4), 313-317.

Purnamawati, Djokosetiyanto, D., Nirmala, K., Surawidjaja, E. H., & Affandi, R. (2017). Survival and growth responses of snakehead fish *Channa striata* Bloch juvenile in aerated and unaerated acid sulfate water. *Jurnal Akuakultur Indonesia 16* (1), 60–67.

Qin, J., Fast, A. W., & Kai, A. T. (1997). Tolerance of snakehead *Channa striata* to ammonia at different pH. *Journal of World Aquaculture Society*, *28*, 87–90.

Qin, J. G., & Fast, A. W. (2003). Intensive culture of snakehead (*Channa striatus*) during larval, juvenile and growth stages. *American Fisheries Society Symposium*, *38*, 33- 41.

Rahman, M. A., Mazid, M. A., Rahman, M. R., Khan, M. N., Hossain, M. A., & Hussain, M. G. (2005). Effect of stocking density on survival and growth of critically endangered mahseer, *Tor putitora* in nursery ponds. *aquaculture*, *249*, 275-284.

Rana, S., Akanda, M. A., Uddin, M. S., Sumon, T. A., Hussain, M. A., Miah, I., Mazumder, S. K., & Hasan, M. T. (2020). Effects of different stocking densities on growth, survival and water quality parameters of *Puntius sophore* in the metallic tray. *5*(*2*), 28-33.

Rawat, A., Raizada, S., & Srivastava, P. P. (2021). Growth and survival of hatchery-produced and feed-weaned striped murrel *Channa striata* (Bloch, 1793) fingerlings in cement tanks. *Indian Journal of Fis*heries, 68(*2*), 52-59.

Sampath, K. (1984). Preliminary report on the effects of feeding frequency in *Channa striata*. *Aquaculture.* 40(4), 301–306.

Syamsunarno, M. B., & Sunarno, M. T. D. (2022). Response of post-larva of snakehead (*Channa striata*) to feeding dried silkworm (*Tubifex sp.*) and artificial diet: Depik. *Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan*, *11*(1), 16-22.