

Effects of different artificial feed brands on growth performance and survival of Air-breathing Shol fish (*Channa striata*) Fry

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Abstract

The striped snakehead (*Channa striata*) is an economically important food fish valued for its meat quality and medicinal properties. The importance of this study is that limited comparative research is available on commercial feed brands for *Channa striata* fry and the outcomes can be used to identify appropriate feeds to enhance fry production. The study was conducted from May to November 2025 under controlled aquarium conditions to evaluate the effects of different commercial artificial feeds on the growth performance and survival of *Channa striata* fry. This study was carried out from May to November 2025 in regulated conditions of the aquarium. Twenty-five fry of *Channa striata* were used to assess the effect of different commercial artificial feeds on growth performance and survival; 16 fries survived at the end of the experimental period. Three commercial feed brands—Quality Gold, Osaka Green, and Tropical Granule Deluxe—were evaluated over a six-month rearing period, along with a mixed-feed treatment and a control. The mixed feed exhibited the highest growth performance, attaining a mean body weight gain of 55.49g and an average total length increment of 15.04 cm, and it also showed the highest survivability rate (80%). The Tropical Granule Deluxe feed produced the second-highest growth performance showing body weight 49.47g and a total length increment of 14.16cm, and survival rate of 80%. The Quality Gold showed moderate growth with body weight gain of 45.14g and total length increase of 13.52 cm, and survivability rate 60%. The Osaka Green feed resulted in comparatively lower growth performance having body weight gain of 38.73g, a length increase of 11.44 cm, and the lowest survivability rate (40%) among all treatments. The control aquarium, supplied with pond water and water hyacinth without any artificial feed, recorded a mean body weight 43.81g, an average total length increment of 10.18 cm, and a survivability rate of 60%. This study provides valuable insights into feed optimization strategies for air-breathing shoal fish and highlights the need for further research on species-specific nutritional requirements.

Keywords: *Channa striata*, Air-breathing Shol fish, Artificial feed, Growth performance, Survival rate.

INTRODUCTION

Aquaculture is the most rapidly expanding sector of global food production, and it is crucial for both food security and nutrition (Kumari *et al.*, 2018). The snakehead, *Channa striata* (Bloch, 1793), is a carnivore freshwater fish and obligate air-breather. It is a member of the Channidae family. It is commonly known as snakehead murrel, chevron snakehead, or striped snakehead (Munir, 2016) and is also referred to as “Shol” fish (Awal *et al.*, 2023). This species is widely distributed across Western and South-east Asian nations, such as Bangladesh, India, China, Cambodia, Indonesia, Myanmar, Laos, Malaysia, Pakistan, Nepal, Sri Lanka, Vietnam, and Thailand (Rawat *et al.*, 2021). They are endemic fish which are crucial to freshwater ecosystems in tropical Africa and Asia (Munafi *et al.*, 2004). The

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Channa striata constitutes 4.2% of the total fish production in Bangladesh and holds economic importance (Awal *et al.*, 2023). A total of 92,523 tons of striped murals is produced worldwide, with aquaculture contributing to 21,721 tons and capture fisheries for 70,802 tons (FAO, 2016). In Bangladesh, *C. striata* is in high demand as a food fish due to its high nutritional value. In numerous countries, snakeheads are highly regarded as edible fish and are frequently employed in aquaculture (Sarker *et al.*, 2021). In addition, it is also used in traditional medicine, where it is believed to enhance immunity, encourage wound healing, and facilitate recovery from disease (Hg *et al.*, 2024). However, despite its potential, commercial *C. striata* farming is still comparatively small and primarily uses wild-caught stock due to feed management issues, high early life stage mortality, and technological difficulties in seed production (Nam *et al.*, 2009).

Due to the presence of an air-breathing organ in *C. striata*, it remains resilient to subpar water quality and can extract oxygen from its surroundings; nevertheless, it is still vulnerable to sudden environmental fluctuations (Awal *et al.*, 2023). It exhibits characteristics that render it a significant species for cultivation, including its elevated market value, rapid growth, resilience to high-density stocking, and capacity to utilize ambient oxygen for survival in low-oxygen settings (Sampath, 1984). *C. striata* is sometimes considered an invasive or bothersome predator in non-native areas, potentially upsetting local fish communities (Manh *et al.*, 2024). *C. striata* is mostly collected from the wild in various countries, with little regulated cultivation. Domestication represents the initial phase in preserving snakeheads within their indigenous habitat and cultivating their population (Syamsunarno & Sunarno, 2022). The degradation of its feeding, breeding, and nursery grounds is causing a steady decline in its output in Bangladesh. Some study has focused on developments in captive breeding, bloodstock development, hormonal induction, larval rearing, and diet optimization due to declining wild supplies and rising demand (Kumar *et al.*, 2022). Farmers often fail to follow prescribed sanitation protocols for aquaculture production, which results in decline of water quality leading to infection proliferating.

However, there is no commercially produced feed specifically formulated for this species, and only limited empirical data regarding its nutritional needs has been documented thus far (Sarker *et al.*, 2021). Live feed is essential for snakehead cultivation throughout the larval phase and occasionally during the grow-out phase as well (Sarker *et al.*, 2021). Nonetheless, this issue has been partially resolved via the advancement of high-quality artificial diets. The artificial feed improves the growth, feed efficiency, and survival of cultured fish by providing balanced and constant nutrition (Hasan *et al.*, 2025). The cultivation of *C. striata* necessitates live fish fry; however, a prepared diet with 36% protein may enhance growth and feed efficiency in juvenile *C. striata* (Mithu *et al.*, 2017). Protein-rich diets are essential for meeting the metabolic and development requirements of carnivorous species such as *Channa striata* (Hapsari & Tjandrawinata 2025). Thai farmers feed snakeheads with refuse fish, wheat flour, rice bran, vitamins, and minerals (Awal *et al.*, 2023).

Nonetheless, to achieve economic prosperity in snakehead aquaculture, it is essential to enhance feed acceptability, increase feed intake, and minimize feed loss. Feed evaluation is crucial for sustainable aquaculture practices since variations in the nutritional composition of commercial feed brands can have a substantial impact on growth performance and survivorship (Alam, 2020). It is strictly regulated to prevent overfeeding and preserve the purity of the water. The study on feeding rates in snakehead culture shows that changing the feeding rate and frequency affects growth, survival, and feed conversion efficiency (Akbar *et al.*, 2020). The farming of *C. striata* remains limited in Bangladesh's aquarium environments, whether in monoculture or polyculture systems. The present study aimed to determine the preferred commercial feed brand for *C. striata* for growth and to evaluate its survivability under aquarium conditions.

MATERIALS AND METHODS

The study was conducted from May to November 2025 in the aquariums of the fisheries hatchery site at Jahangirnagar University campus (Figure 1), located 32km northwest of Dhaka city in central Bangladesh (Shoma and Begum, 2020). The campus is situated at 23°52.764' N latitude and 90°16.068' E longitude, covering an area of approximately 280 hectares. This area is part of the Bhawal and Madhupur tracts (Mahanta *et al.* 2014). For this study, sampling was done throughout the northern regions of Bangladesh.

Experimental Design: Twenty-five Shol (*Channa striata*) fry were collected by a net from a local freshwater pond of Rangpur District, northern Bangladesh. The water sample was taken from the lake besides the Fisheries Hatchery. To ensure adequate aeration and prevent fish escape throughout the experimental period, all aquaria were maintained at uniform dimensions (43× 76 cm), with an approximate freeboard of 25 cm above the water surface. Prior to stocking, all five tanks were filled with water. During the experimental period, each aquarium was maintained at a constant water volume of 20 gallons (approximately 75.7 liters) using pond water. In order to facilitate appropriate acclimation and promote healthy growth under experimental settings, fish were carefully introduced into the aquariums. In the present study, the experimental fish were provided with different dietary treatments across five aquaria. Aquarium I was supplied with Quality Gold, Aquarium II with Osaka Green, Aquarium III with Tropical Granules Deluxe. Aquarium IV served as control and received only pond water with water hyacinth), while Aquarium V (mixed feed) was maintained with pond water, water-hyacinth, and all three artificial feed brands which are used in aquarium I-III. The total daily feeding ratio (6–8% of body weight) was divided into two equal portions and administered twice daily. A uniform feeding schedule was maintained across all treatments, with feeding conducted at 9:00 a.m. and 3:00 p.m. each day. The nutritional composition of the fish feed used in this study is shown in Table 2. Every day, the water surface was gently stirred before feeding to help maintain dissolved oxygen (DO) levels and allow excess carbon dioxide (CO₂) to escape from the water.

Measurement of physio-chemical parameters: The parameters were measured at weekly intervals on the first day of each week at 10:00 a.m. Key water quality parameters of the experimental tanks, including temperature, pH, dissolved oxygen (DO), and alkalinity,

which were regularly monitored. A centigrade thermometer was used to determine the temperature; a digital electronic meter (Eutec) was used to measure the pH; titration methods were used to measure the total alkalinity, dissolved oxygen, and free carbon dioxide (Raizada *et al.*, 2012).

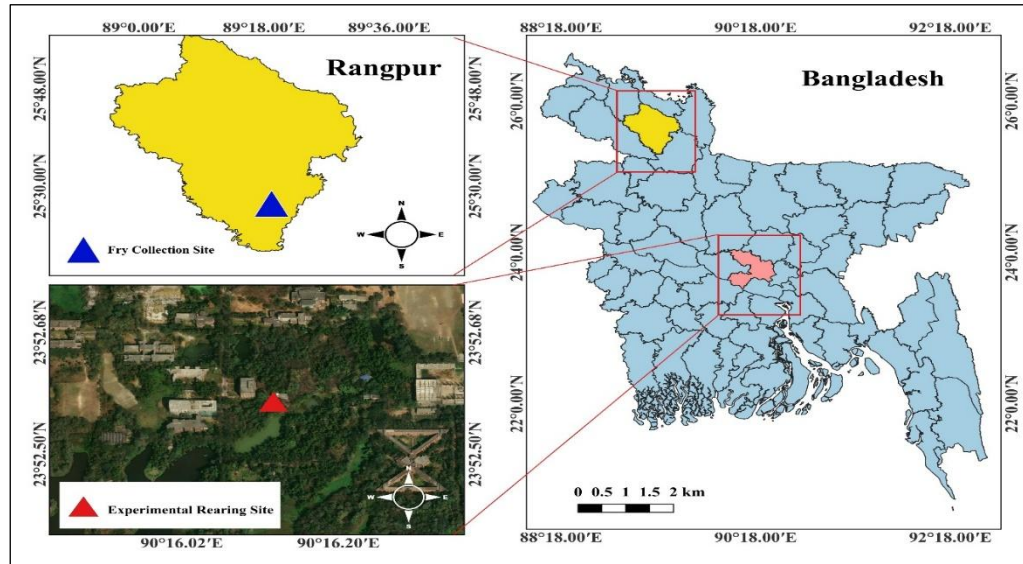


Fig. 1. Map showing the fry collection and experimental rearing sites of the study area

Description of the aquarium conditions

Water quality parameters: Table 1 displays the results of tests on water quality variables. The temperature of the water was ranged from 28.24 ± 3.44 °C to 28.66 ± 3.27 °C. A₃ had the lowest mean water temperature (28.24°C), while A₄ had the highest (28.66°C). There were no significant variations in temperature between treatments ($p > 0.05$). Fish metabolism depends substantially on temperature, so it's crucial to regulate it precisely (Kumari *et al.*, 2018). According to Akhteruzzaman (1988), water temperatures from 25 to 35°C is ideal for fish culture. Water temperature was found to be in suitable ranges required for aquaculture in all treatments and findings for culturing *C. striata* fry were in good alignment with those reported by Rahman *et al.* (2005). There was no significant difference ($p > 0.05$) in dissolved oxygen between treatments. The maximum value of dissolved oxygen (DO) of 5.42 mg/L was recorded in A₄ whereas A₁ showed the lowest value of 5.04 mg/L. According to Awal *et al.* (2023) the highest dissolved oxygen value of 5.32 mg/L, and the lowest of 5.09 mg/L and which closely resembles the findings of the present study. During the monsoon season, fish and other aquatic organisms may use oxygen at different rates, and dissolved oxygen levels may fluctuate due to various factors (Awal *et al.*, 2023). Kumari *et al.* (2018) reported dissolved oxygen levels ranging from 6.2 to 7.1 mg/L during their experiment. The snakehead fish has a respiratory organ called diverticula that allows it to live in oxygen-depleted water and use oxygen from the air. Therefore, even if the average dissolved oxygen level is less than 5 mg/L for an extended period of time, the fish

will not still die (Awal *et al.*, 2023). There were no statistically significant variations ($p > 0.05$) in pH between the treatments. The highest value of pH (7.84) was recorded in A_{IV} and lowest in A₃ (7.63). The pH of a water body is a crucial factor in determining its productivity for fish culture. The ideal pH ranges for pond fish culture are 6.5 to 8.5. During the experiment, the pH remained in the alkaline range (Awal *et al.*, 2023). In the current investigation, the higher level of alkalinity (118.56 mg/L) was observed in A₄ and lower level (117.3 mg/L) identified in A₁. There were no significant differences in total alkalinity values between aquariums ($p > 0.05$). The total alkalinity values varied from 115.21±0.66 to 118.22±0.41 mg/L across the treatments (Pervin *et al.*, 2026). There was no statistically significant variance ($p > 0.05$) in CO₂ between treatments. The highest value of CO₂ (3.09 mg/L) was exhibited in A₄ and lowest in A₂ (2.87 mg/L). Water quality significantly impacts the health and growth of aquatic organisms in aquaculture (Boyd and Tucker, 2012). Excessive water quality parameters such as DO, temperature, alkalinity, CO₂ and pH can hinder fish growth and even cause death (Purnamawati *et al.*, 2017)

Table 1. Water quality parameters of different aquariums

Parameters	Aquariums					Standard range
	A ₁	A ₂	A ₃	A ₄	A ₅	
Water temperature (°C)	28.49±3.71	28.62±3.90	28.24±3.44	28.66±3.27	28.33±3.08	26-31°C (Awal <i>et al.</i> , 2023)
pH	7.81±0.06	7.65±0.18	7.63±0.09	7.84±0.11	7.78±0.08	6.5-8.5 (Awal <i>et al.</i> , 2023)
Dissolved Oxygen (DO) (mg/L)	5.04±0.23	5.21±0.09	5.09±0.17	5.42±0.04	5.28±0.13	4-7 mg/L (Awal <i>et al.</i> , 2023)
Total Alkalinity (mg/L)	117.3±1.34	117.9±1.21	116.12±1.52	118.56±1.68	117.5±1.31	70-190 mg/L (Awal <i>et al.</i> , 2023)
Free carbon dioxide (CO ₂) (mg/L)	2.91±0.02	2.87±0.09	3.01±0.10	3.09±0.23	2.98±0.08	<5 mg/L (Lal <i>et al.</i> , 2025)

Sampling procedure and growth monitoring: To evaluate growth performance and survivorship, each fish was distinguished by colour marking on the caudal (tail) fin. Each fish was marked by five different colours and the colour marks were renewed at 15-day intervals during the rearing period to keep identification clearly. The tail colour marking has previously been used as a practical method for individual identification of small fishes (Pitsch *et al.*, 2021). The fish were weighed every 15 days throughout the rearing period. Weight was measured with an analytical balance (g), and length was measured with a scale (cm). To prevent weight errors due to feed remaining in the intestines. Fry samples were also collected during each weekly observation to evaluate their growth performance and survival throughout the study.

The average total length was calculated using the formula (Awal *et al.*, 2023):

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

Similarly, the average Body Weight (WB) was estimated using the formula (Awal *et al.*, 2023):

Body Weight (g) = *Mean final weight (g) – Mean initial weight (g)*

Survival rate was calculated as (Yasmin *et al.*, 2023):

$$\text{Survival Rate} = \frac{\text{Number of surviving fish}}{\text{Number of fish (fry) stocked}} \times 100$$

Table 2. Nutritional composition (%) of fish feed used in this study

Nutritional composition	Quality Gold Brand	Osaka Green Brand	Tropical Granule Deluxe Brand
Crude protein	33 (min)	28	46
Crude fat	4 (min)	3	6
Crude fiber	4 (max)	4	5
Moisture	10	10	6
Ash	-	-	8

Statistical analysis: The entire statistical analysis was carried out using MS Excel 2016. Origin Pro 2026 was used to create regression graphs and analyze the length-weight relationship (Haque *et al.*, 2022). QGIS (Version 3.44.12) was used to create the study area map.

RESULTS AND DISCUSSION

C. striata attained an average length and weight of 11.40±4.25 cm and 23.02±14.24 gm with the feed of Quality Gold, while it was 11.25±3.11 cm and 20.53±12.63 gm for Osaka Green, 11.90±4.43 cm and 23.30±15.80 gm for Tropical granules deluxe, 9.92±3.01 cm and 21.68±13.65 gm for control, and 12.65±4.62 cm and 26.93±16.96 for mixed diet.

Growth performance of *Channa striata* fry: The investigation showed that using three different kinds of fish feed resulted variations in the growth rate of *Channa striata*. The different types and nutritional contents of the feeds had a significant impact on these variances. After six months, there were notable differences in the growth performance of *C. striata* fry between the various aquarium groups. The “Quality Gold” feed was given to the fish kept in Aquarium I. The fish's total length and weight at the start of the trial were 4.08 cm and 0.66 g, respectively. The fish showed a rise of 13.52 cm (331.37%) in overall length and 45.14 g (6939.39%) in body weight after six months of rearing resulting in final values of 17.6 cm in total length (Table 3) and 45.8 g in weight (Table 4). The results showed that the fish grew considerably in body length and weight during the six-month rearing period.

The Osaka Green diet was provided in the Aquarium II. The initial average body weight and total length were 0.67 g and 4.16 cm, respectively. During the six-month experimental period, the fish showed substantial growth of 38.73 g (5780.60%) body weight and 11.44 cm (275%) total length. Consequently, the final average weight and total length were 39.4

g and 15.6 cm, respectively, (Table 3 and 4) showing a considerably improvement in growth performance. The Tropical Granule Deluxe Brand feed was used in the Aquarium III, the initial mean length and body weight of the supplying fish were 4.24 cm and 0.73 g, respectively. The fish showed an overall length and body weight increase of 14.16 cm and 49.47 g, which were 333.96% and 6776.71% of their initial values during the six-month rearing period. The final mean length and body weight were 18.4 cm and 50.2 g respectively (Table 3 and 4).

Fish reared in aquarium water without any supplementary artificial feed exhibited an initial average length of 4.22 cm and a body weight of 0.69 g. Over the six-month experimental period, the fish gained 10.18 cm in length and 43.81 g in body weight, representing increases of 241.23% and 6349.28% over their initial values, respectively. The final mean length and body weight at the final stage of the rearing period were 14.4 cm and 44.5 g respectively. (Table 3 and 4). Using a selective diet, Muntaziana *et al.* (2013) investigated the growth and survival of Shol fish (*Channa striata*) fry and reported notable improvements in weight gain and growth performance. Consistent with earlier findings by Mollah *et al.* (1990), the observed variation in weight gain underscores the critical importance of feed composition and the balance of dietary ingredients. The mixed feed diet was given to the fish in Aquarium V. The initial measurements revealed a mean weight of 0.71 g and an average total length of 4.36 cm. The body weight and total length increased by 55.49 g and 15.04 cm during the six months rearing period, which represented the overall gains of 7815.49% and 344.95%, respectively, compared to the initial measurements. Consequently, growth performance improved markedly, with the final total length and body recorded as 19.4 cm and 56.2 g, respectively (Table 3 and 4).

Table 3. Total length (cm) of *C. striata* for different treatments

Aquarium I			Aquarium II			Aquarium III			Aquarium IV			Aquarium V		
Feed types	Initial length (cm)	Final length (cm)	Feed types	Initial length (cm)	Final length (cm)	Feed types	Initial length (cm)	Final length (cm)	Feed type	Initial length (cm)	Final length (cm)	Feed type	Initial Length (cm)	Final length (cm)
Quality Gold	4.08	17.6	Osaka Green	4.16	15.6	Tropical granules deluxe	4.26	18.4	Control	4.22	14.4	Mixed-feed	4.36	19.4

Table 4. Total Body weight (BW) (cm) of *C. striata* for different treatments

Feed types	Aquarium I		Feed types	Aquarium II		Feed types	Aquarium III		Feed type	Aquarium IV		Feed type	Aquarium V	
	Initial BW (gm)	Final BW (gm)		Initial BW (gm)	Final BW (gm)		Initial BW (gm)	Final BW (gm)		Initial BW (gm)	Final BW (gm)		Initial BW (gm)	Final BW (gm)
Quality Gold	0.66	45.8	Osaka Green	0.67	39.4	Tropical granules deluxe	0.73	50.2	Control	0.69	44.5	Mixed-feed	0.71	56.2

The results presented in the five tables indicate variation in growth performance among different dietary treatments. The mixed feed treatment resulted in the highest increases in both body weight and length, whereas fish fed Osaka Green showed comparatively lower growth performance. Although growth varied treatments, mean body weight length showed a consistent increasing trend throughout the experimental period in all groups. The results were in alignment with the findings of Mohanty and Samantaray (1996) who observed that *C. striata* fry fed mixed diet containing natural ingredients at a daily feeding rate of 10% body weight showed the best growth performance. This similarity could be because both studies used a mixed diet, which provided a balanced mix of nutrients and helped to improve the growth performance of *C. striata* fry. Similar findings have been reported for juvenile *C. striata*, *C. micropeltes*, *Chanos chanos*, *Epinephelus tauvina*, *Cyprinus carpio*, *Ictalurus punctatus*, and *Sarotherodon mossambicus* (Srivastava *et al.*, 2012). For *C. striatus* to grow more effectively, the diet with 49.72% protein and 13.54% fat was ideal (Srivastava *et al.*, 2012). Qin *et al.* (1997) reported on the growth and survival of larval snakehead (*Channa striatus*) fed various diets. Species, size, age, season, protein quality, dietary energy content, water quality, the presence of natural food, and culture management all have a significant impact on the amount of protein available in body carcasses (Gam *et al.*, 2006). These findings highlight the importance of selecting nutritionally balanced diets to optimize the growth of *Channa striata*. Furthermore, previous studies have reported that fish growth and production can more than double under artificial feeding regimes in polyculture systems (Hasan *et al.*, 2025).

Linear regression analysis of the Length–Weight relationship of *Channa striata* fry:

The weight-length data noted that both weight and length tend to enhance progressively. The relationship between the weight and length of *Channa striata* fry was evaluated using a linear correlation analysis. A strong positive relationship was observed between length and weight under every dietary treatment including Quality Gold ($r=0.99$), Osaka green ($r=0.99$), Tropical granules deluxe ($r=0.98$), Control ($r=0.99$) and Mixed diet ($r=0.99$) (Figure 2) and the relationships were statistically significant ($p < 0.05$). A strong linear regression was recorded within Length–Weight relationship throughout the culture period (Yadav *et al.*, 2016). The relationship coefficient values found in this study were basically the same as those found in the natural *C. marulius* stock in India (Khan *et al.*, 2012).

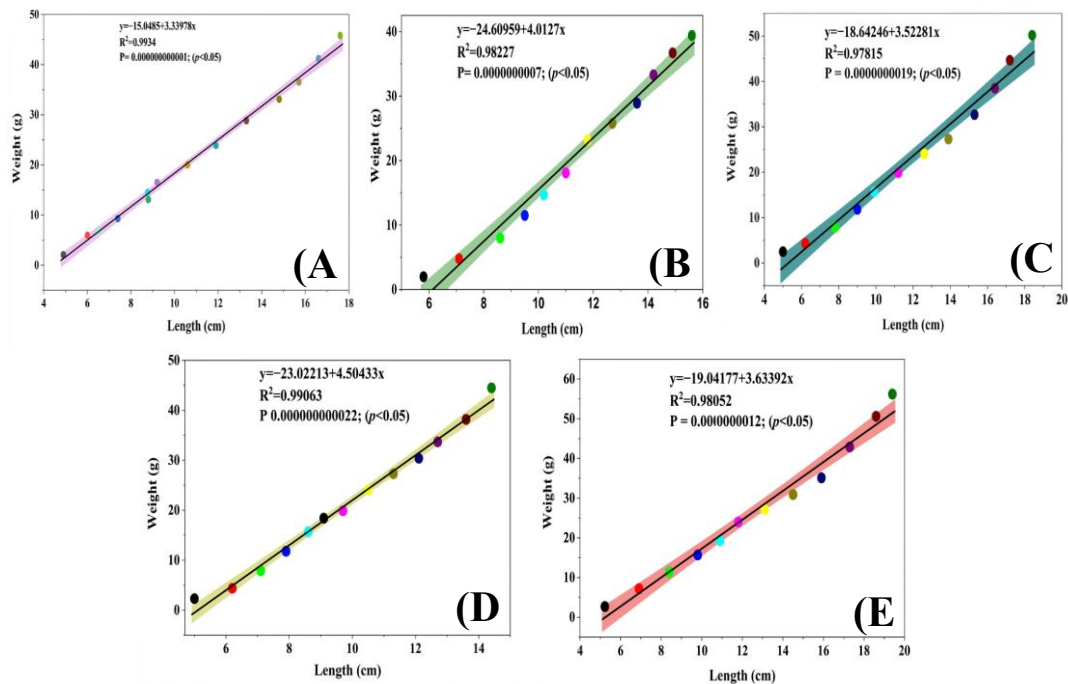


Fig. 2. Length-weight relationship of *Channa striata* with different fed type (A) Quality Gold, (B) Osaka Green, (C) Tropical Granules Deluxe, (D) Control and (E) Mixed Diet

Survival rate: The water quality was monitored during the experiment and all parameters were within the acceptable range. Therefore, it is unlikely that water quality was the cause of mortality observed. Alternatively, the mortality may have been associated with differences in feed type, feeding response or feed suitability between the treatments. The survival rate of *Channa striata* varied among dietary treatments, with the highest survival rate (80%) in both the Tropical Granule Deluxe and Mixed feed groups and the lowest rate (40%) in the Osaka Green. The survival rate for Quality Gold and Control group was the same that was 60% (Figure 3). The survival rate of *C. marulius* was documented at 22.54% following 12 months of rearing on the same mixed diet used in the present study (Yadav *et al.*, 2016) and the survival rates were significantly higher ($p < 0.05$) in mixed diets (Raizada *et al.*, 2012). The survival rate of *Channa striatus* ranged from 74 ± 1.2 to $82 \pm 3.1\%$ in mixed diets (Srivastava *et al.*, 2012) which is consistent with the findings of the present study. The main reason of mortality in snakehead culture has been attributed to its cannibalistic behavior (PKL, 1990), which is more prevalent in smaller groups of *C. striatus* (Qin & Fast, 1996). While it is known that *C. marulius* is more predatory and cannibalistic than *C. striatus*, no data is available regarding the predator-prey ratio in this species (Srivastava *et al.*, 2012). During cannibalism, shooters can target fish measuring $2/3$ cm of their length or 63-80% (Qin and Fast 1996) relative to the size of *C. striatus* (Srivastava *et al.*, 2012). Several studies have shown that mixed feed significantly improve survival rates in fish with high levels of cannibalism (Manica, 2004; Kvarnemo *et al.*, 1998).

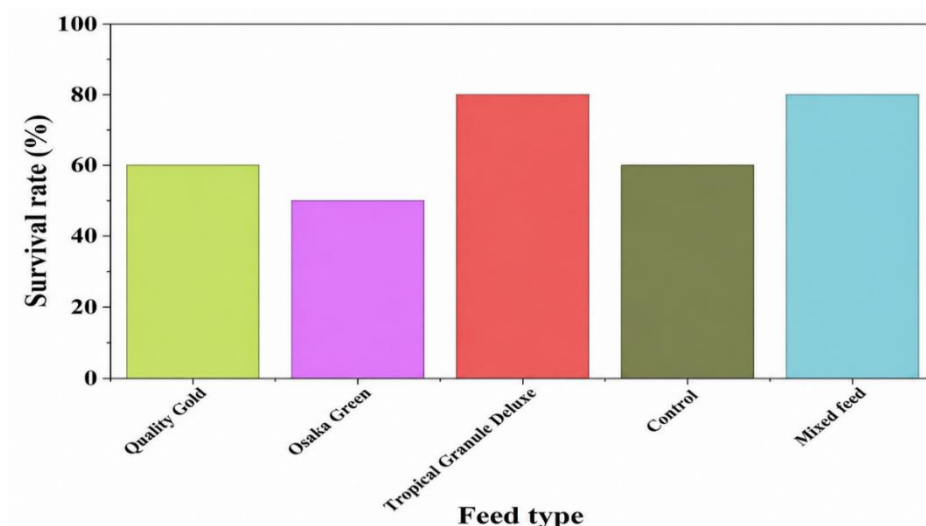


Fig. 3. Survival Rate on different artificial feed brands and control conditions

Conclusion: The current study emphasizes the importance of feed types and dietary combinations in influencing the growth performance of *Channa striata* fry. The mixed-feed diet yielded the highest average gains in body weight and total length among the studied aquariums. Tropical Granule Deluxe outperformed Quality Gold and Osaka Green among the commercial feeds. Both Quality Gold and Osaka Green showed comparable increases in length, but their weight gains were significantly different, with Osaka Green displaying the least growth. Fish fed only natural food (control) grow more slowly, indicating that natural food is not enough for their best possible development. In general, the study highlights the benefits of integrated feeding strategies over relying only on natural food. A well-balanced nutritional formulation may be crucial for improving growth, as evident by Tropical feed's higher performance. However, the study had limitations including a small sample size, limited replication and a short study period. To enhance the accuracy of the findings, future studies should include larger sample sizes, more replicates, longer experimental periods, and a wider assessment of feed quality and nutritional composition. These findings provide valuable insights for enhancing feed management procedures and encouraging sustainable aquaculture output.

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