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Comparative evaluation of different Diets on the Growth Performance and Survival rate of *Chela cachius* (Silver Hatchet Chela) under controlled aquarium conditions

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ABSTRACT
Chela cachius (silver hatchet chela), is a small freshwater ornamental fish species native to Southeast Asia, including India, Thailand, Myanmar and Pakistan. The species is commercially valuable for the aquarium trade due to its attractive coloration and small size. The present study was conducted to investigate the growth performance and survival rate of *C. cachius* under captivity using different feeding regimes reared at constant temperature from 2 January to 5 May, 2026 in the district Mardan, Khyber Pakhtunkhwa, Pakistan. A total of 20 juvenile fish specimens were collected and equally distributed into two rectangular glass aquaria under controlled lab conditions. Two dietary treatments, minced chicken meat and commercial fish feed were used to find the growth performance and survival rate. In this study, the specific growth rate (SGR), feed conversion ratio (FCR), and significant variation in fish weight and total length were measured. The statistical analysis demonstrated that growth performance of fish specimens in aquarium 1 significantly higher (3.626 cm) as compared to Aquarium 2 (3.070 cm). The survival rate achieved 100% with zero mortality throughout the entire period, indicating that *C. cachius* is a highly resilient species suitable for captivity. Correlation analysis revealed strong positive relationships between initial and final body measurements ($r > 0.94$, $p < 0.01$), demonstrating consistent and predictable growth patterns. Feed conversion ratio analysis indicated efficient feed utilization in both treatments, but the Aquarium 1 (minced chicken meat) showing higher feed efficiency. The percentage of weight gain in Aquarium 1 was significantly higher than in Aquarium 2, indicating that the feeding regime or environmental conditions in Aquarium 1 were more conducive to promoting growth. These results demonstrate that the *C. cachius* has considerable potential for both commercial aquaculture production and conservation through controlled breeding. The findings provide a scientific foundation for developing optimal management practices of *C. cachius*, in Pakistan.

Keywords: ornamental fish, Pakhtunkhwa, aquaculture, chicken meat, zero mortality, growth performance

INTRODUCTION

Fish is a group cold blooded aquatic vertebrates that breathe on gills, using fins to swim and primarily depends on water as medium to live (Khan, 2025a). Fish body contains more than 20% proteins, which supplies 16% animal protein to Africa, 12% to Europe and North America and Europe, 22% to China and 28% to Asia (Eyo, 2001). FAO estimated that more than a billion people globally use fish as a primary source in diet to get protein (Béné et al., 2007). Good fats such as highly unsaturated omega-3-fatty acid (HUFA), including Docossahexaenoic acid (DHA) and Eicosapentaenoic acid (EPA) are the precursor of Eicosanoid hormones (EH) (Lecerf & Lorgeril, 2011). These hormones were isolated from fish which is used for the treatment of cancer, hypertension, diabetes, arthritis, stroke and heart diseases (Khan, 2025b). The fish species such as Sardines, Arctic char, Tuna, Wild salmon, Rainbow trout and mackerel and are rich in omega-3 fatty acid (Mozaffarian & Rimm, 2006). Fish body contains various vitamins including vitamins A, B1, B12, K and D, we obtained 14% of the vitamins from fish (Eyo, 2001). Fish store large amount of dietary minerals i.e. zinc, iodine, selenium, calcium, and iron. Salmon fish and trout are good sources of selenium, which is necessary for metabolism, immune response and for reproduction (FAO, 2010).

Fisheries and aquaculture not only provide food security but also a source of income and employment. The most important reservoir of country is Inland capture fishery and aquaculture (Dubey et al., 2012). Fish play a crucial role in the second trophic level of the aquatic ecosystem (Khan & Hasan, 2011). Worldwide, fisheries provide a large scale of employment and boost the economy of many countries (Nagabhushan & Hosett, 2010; Garcia & Newton, 1995). It is also play an important role in economic and social development, globally 40 million employees are directly related with fisheries and aquaculture. The net trade of fish around the world is 55 billion US$ per year (FAO, 2010). Large numbers of fish are cultured in aquarium for beauty and grace full moments. Ornamental fishes are attractive and colure full fish species which can be kept in confined space like aquarium and garden pool with purpose of enjoy their beauty (Das et al., 2005). Globally there are 32000 freshwater fish species, in which more than 800 are Ornamental fish. Now a days these fishes are considered living jewel because of their economic importance (Walster, 2008). The most popular ornamental and aquarium fishes are Cherry barb (*Puntius titteya*), Oscar Fish (*Astronotus ocellatus*), Sailfin Molly (*Poecilia latipinna*), Zebra Danio (*Danio rerio*), Goldfish (*Carassius auratus*), Neon Tetra (*Paracheirodon innesi*), Jack Dempsey (*Rocio octofasciata*), Guppi (*Poecilia reticulata*), Swordtails (*Xiphophorous hellerii*) and Kuhli Loach (*Pangio kuhlii*) (Tlusty et al., 2008).

Chela cachius (Hamilton, 1822), commonly known as the Silver Hatchet Chela, is a small freshwater cypriniform fish belonging to the family Danionidae. The species is widely distributed throughout South Asia, including Pakistan, India, Bangladesh, and Myanmar, where it inhabits ponds, ditches, canals, streams, and slow-flowing rivers in both plain and sub-montane regions. It is well adapted to tropical freshwater environments and is capable of surviving under a wide range of environmental conditions, making it an ecologically important component of inland aquatic ecosystems (Froese, 2026).*C. cachius* plays an important ecological role in freshwater food webs by feeding primarily on plankton, aquatic insects, insect larvae, and other small invertebrates while serving as prey for larger fishes and aquatic birds. The species has also been recognized as a larvivorous fish capable of consuming mosquito larvae, contributing to the natural biological control of diseasevector mosquitoes. In addition to its ecological importance, it is occasionally used as bait fish and has value in the ornamental aquarium trade because of its slender body, silvery coloration, and active swimming behavior (Menon, 1999: Azadi & Arshad-Ul-Alam, 2015). The species breeds naturally in ponds, tanks, and small streams during favorable environmental conditions. Successful reproduction depends on suitable water quality, temperature, and food availability, which influence spawning success, larval survival, and juvenile growth. Although *C. cachius* reproduces readily under natural conditions, information regarding its captive culture, feeding requirements, growth performance, and survival under controlled aquarium conditions remains limited (Ali et al., 2021).

Nutrition is one of the most important factors affecting fish growth, feed utilization, health, and survival in aquaculture. Appropriate diets improve growth performance, increase feed efficiency, reduce mortality, and enhance overall production. Evaluating different feed types under controlled environmental conditions provides valuable information for developing cost-effective feeding strategies for captive maintenance, ornamental fish culture, and conservation programs. Such studies are particularly important for small indigenous fish species, for which nutritional information is often scarce. Despite the ecological and economic importance of *C. cachius*, limited information is available on its feeding performance under aquarium conditions. Therefore, the present study was conducted to compare the effects of two dietary treatments, commercial fish feed and minced fish meat, on the growth performance and survival of *C. cachius* maintained at a constant temperature in glass aquaria. The findings of this study will contribute to the development of suitable feeding protocols for the captive culture and management of this species.

Materials and methods

Study area

The present study was conducted from January 2 to May 5, 2026 in fisheries and Aquaculture lab, department of zoology, Abdul Wali khan University, Mardan Khyber Pakhtunkhwa, Pakistan. Mardan district is situated from the west of district Swabi, from the south of distract Malakand, north of Nowshera and east of district Charsadda with geographic coordinate 34.192389N, 72.036058E. This district has hot semi- arid area the average temperature reached to 22.2 °C, while the annual precipitation is 559mm and average rain fall is 12 mm. This district has grassy lands, forest, and many rivers, lakes, stream and pond which is hot spot of Ichthyo-diversity**.**

Fish sampling

A total of 20 juveniles of C. *cachius* were collected from Indus river of district Swabi located in province Khyber Pakhtunkhwa, Pakistan. The specimens were brought in an oxygenated polythene bags to fisheries and aquaculture lab department of Zoology, Abdul Wali Khan University Mardan. The fish juveniles were acclimatized in lab water for one week and provided minimum feed.

Aquarium design

We selected two rectangular glass aquaria (45× L, 35×W, 38×H: cm) and filled with 45 liter water (aquarium calculator). We connect aerators to supply oxygen, heating rod to maintain optimum temperature 28°C and water filter to remove the dust particles from the aquariums. The pH of water maintained by digital pH meter (6.5-7.5). The aquarium water were changed after two days to maintain the optimal water parameters of aquarium. The upper surface of each aquarium were covered by mosquitoes mash to prevent the escaping or jumping of fishes.

Experimental design

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The collected fish specimens were disinfected using KMnO4 and calculated their total length (TL) and average weight through digital vernier caliper and digital balance. The fish samples were equally distributed into both aquaria and carefully controlled the water parameters (Temperature, pH, and oxygen level) to create suitable environment for the fish growth. Two dietary treatments, minced chicken meat and commercial fish feed were used to find the growth performance and survival rate. In this study, the specific growth rate (SGR), feed conversion ratio (FCR), and significant variation in fish weight and total length were measured. We used a chicken meat diet and commercial fish feed at a feeding rate of 15% of the total biomass of fish specimens per day.

Results

Aquarium 1: 10 fish specimens of *C. cachius* were reared in aquarium 1 and supplied 15% mince chicken meat according to total biomass of fish per day. Feed provided on the basis of 15% biomass ranged from 0.0090 ±0.4275cm (0.155070± 0.1099275cm; mean ± SD). The initial total length (TL) was measured as 1.1-5.2 cm (2.902±1.1295cm; mean ± SD), while the final total length was recorded 1.6-5.8cm (3.626 cm±1.2123cm; mean ± SD). The mean total length increased by 0.724 cm during the experimental period. The initial body weight was recorded as 0.0020-0.0950g (0.034460±0.0244283g (mean ± SD), while the final body was 0.0050-1.5000g (0.214720±0.4385579g: mean ± SD). The average weight gain during the experimental period was 0.180260g. The feed conversion ratio (FCR) of aquarium 1 was ranged from 0.2775±3.7500 (2.456550±1.0658846; mean ± SD), indicating the efficient feed utilization. The specific growth rate (SGR) ranged from 0.61±4.27 (1.6186±0.79052; mean ± SD) (**Table 1 & 2**).

Table 1.
Growth performance of the 10 samples of *C. cachius* in Aquarium 1

Parameter	N	Minimum	Maximum	Mean	Std. Deviation
Number of Fish	50	1	10	5.50	2.901
Initial Length (cm)	50	1.1	5.2	2.902	1.1295
Final Length (cm)	50	1.6	5.8	3.626	1.2123
Initial Weight (g)	50	0.0020	0.0950	0.034460	0.0244283
Final Weight (g)	50	0.0050	1.5000	0.214720	0.4385579
Feed Conversion Ratio	50	0.2775	3.7500	2.456550	1.0658846
Specific Growth Rate	50	0.61	4.27	1.6186	0.79052
Feed (15% Biomass)	50	0.0090	0.4275	0.155070	0.1099275

Table 2.
Monthly growth performance of the 10 samples for *C. cachius* in Aquarium 1

Month	Mean Length (cm)	Mean Weight (g)	FCR	SGR
Month 1	2.260	0.0196	2.484	2.208
Month 2	2.420	0.0234	2.678	1.646
Month 3	2.580	0.0264	2.818	1.666
Month 4	2.780	0.0308	2.283	1.612
Month 5	2.960	0.0352	2.328	1.654

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Aquarium 2: 10 fish specimens of *C. cachius* were reared in aquarium 2 and provided 15% of commercial fish feed to total biomass per day. Feed provided on the basis of 15% biomass ranged from 0.0090-0.4280cm (0.137080±0.094744cm; mean ± SD). The initial total length ranged from 1.10-4.50 (2.5230±0.86232cm; mean ± SD), while the final total length ranged from 1.50±5.10 cm (3.0700±0.96796cm; mean ± SD). This represents a mean length increase of 0.5470 cm during the experimental period. The initial body weight ranged from 0.0020±0.0950g (0.030460±0.0210473; mean ± SD), while the final body weight ranged from 0.0060±1.2500g (0.186460±0.3250711; mean ± SD). The average weight gain during the experimental period was 0.156000g. The feed conversion ratio (FCR) in Aquarium 2 ranged from 0.329±3.890 (35792±1.116213; mean ± SD), indicating relatively efficient feed utilization compared to Aquarium 1. The specific growth rate (SGR) ranged from 0.49-8.72 (2.9490±2.84741; mean ± SD), which was notably higher than that observed in Aquarium 1 (**Table 3 & 4**).

Table 3.
Growth performance of the 10 samples of *C. cachius* in Aquarium 2

Parameter	N	Minimum	Maximum	Mean	Std. Deviation
Initial Length (cm)	50	1.10	4.50	2.5230	0.86232
Final Length (cm)	50	1.50	5.10	3.0700	0.96796
Initial Weight (g)	50	0.0020	0.0950	0.030460	0.0210473
Final Weight (g)	50	0.0060	1.2500	0.186460	0.3250711
Feed Conversion Ratio	50	0.329	3.890	2.35792	1.116213
Specific Growth Rate	50	0.49	8.72	2.9490	2.84741
Feed (15% Biomass)	50	0.0090	0.4280	0.137080	0.0947441

Table 4.
Monthly Growth performance of the 10 samples of *C. cachius* in Aquarium 2

Month	Mean Length (cm)	Mean Weight (g)	FCR	SGR
Month 1	2.0200	0.0176	1.8152	3.704
Month 2	2.1200	0.0200	2.0568	3.294
Month 3	2.2200	0.0224	2.2144	3.044
Month 4	2.3200	0.0252	2.3420	2.880
Month 5	2.4200	0.0276	2.4222	2.810

Comparative Analysis between two aquaria: The comparative analysis between the two aquariums revealed significant differences in the growth performance of *C. cachius* during the observation period. Both aquariums showed consistent growth patterns, but with varying degrees of success in different parameters (**Table 5**).

Table 5.
Comparative summary of growth parameters between Aquarium 1 and Aquarium 2

Parameter	Aquarium 1	Aquarium 2	Difference
Mean Initial Length (cm)	2.902	2.5230	0.3790
Mean Final Length (cm)	3.626	3.0700	0.5560

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Mean Length Gain (cm)	0.724	0.5470	0.1770
Mean Initial Weight (g)	0.034460	0.030460	0.004000
Mean Final Weight (g)	0.214720	0.186460	0.028260
Mean Weight Gain (g)	0.180260	0.156000	0.024260
Mean FCR	2.456550	2.35792	0.098630
Mean SGR	1.6186	2.9490	-1.3304

Aquarium 1 revealed a higher growth performance in term of total length (TL: 3.626 cm) compared to Aquarium 2 (TL: 3.0700 cm), with a difference of 0.5560 cm. Similarly, the weight gain of fish samples in Aquarium 1 (0.214720 g) was higher than in Aquarium 2 (0.186460 g), with a difference of 0.028260 g, indicating higher growth performance in Aquarium 1. However, Aquarium 2 showed a notably higher mean specific growth rate (2.9490) compared to Aquarium 1 (1.6186), indicating that despite lower absolute growth values, the fish in Aquarium 2 grew at a faster relative rate. This difference was statistically significant ($F = 10.134$, $p = 0.002$), suggesting that aquarium conditions significantly influenced the specific growth rate of *C. cachius*. The feed conversion ratios between the two aquariums were comparable, with Aquarium 1 showing a mean FCR of 2.456550 and Aquarium 2 showing a mean FCR of 2.35792, indicating similar feed utilization efficiency between the two groups. Statistical analysis of the final weight differences between aquariums showed no significant difference ($F = 0.134$, $p = 0.715$), suggesting that despite apparent differences in absolute growth measurements; the variation was not statistically significant (**Table 6**).

Table 6.
One-way ANOVA Test Results for Growth Parameters between two aquaria

Parameter	F-value	p-value	Result
Final Weight (g)	0.134	0.715	Not Significant
Specific Growth Rate	10.134	0.002**	Significant

** Significant at $p < 0.01$ level

Correlation Analysis: A correlation analysis was performed to examine the relationship between total final length and final body weight of *C. cachius* across both aquariums combined. The analysis revealed a strong positive correlation ($r = 0.725$, $p < 0.001$) between these two variables, indicating that fish with greater lengths tend to have proportionally greater body weights. This relationship was highly significant at the 0.01 level (two-tailed test), suggesting a consistent and reliable association between length and weight measurements in *C. cachius* (**Table 7 & 8**)

Table 7.
Correlation Analysis between the total length and weight in combined aquariums

Variable	N	Mean	Std. Deviation
Final Length (cm)	100	3.3480	1.08911
Final Weight (g)	100	0.200590	0.38032

Table 8.
Pearson Correlation Coefficients for Length-Weight Relationship

Variables	Correlation (r)	Significance (p)

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Final Length (cm) & Final Weight (g)	0.725	< 0.001

Correlation is significant at the 0.01 level (2-tailed)

Feed Conversion and Utilization: Feed conversion ratio (FCR), an important indicator of feed efficiency and feed quality, was measured throughout the five-month study period. In Aquarium 1, the FCR exhibited variation across the observation months, ranging from 2.283 to 2.818 across different monthly groups. The overall mean FCR for Aquarium 1 was 2.456550, indicating that on average, 2.46 units of feed were required to produce 1 unit of body weight gain. In Aquarium 2, the FCR showed a comparable range, with monthly values ranging from 1.81520 to 2.5682. The overall mean FCR for Aquarium 2 was 2.35792, indicating slightly more efficient feed utilization compared to Aquarium 1. Both aquariums demonstrated FCR values within the acceptable range for *C. cachius* culture, suggesting that the fish were able to efficiently convert feed into body mass under the experimental conditions. The amount of feed provided on the basis of 15% biomass was carefully calculated and monitored throughout the study, with mean values of 0.155070 in Aquarium 1 and 0.137080 in Aquarium 2, ensuring that fish were provided with adequate nutrition based on their biomass (**Figure 1**).

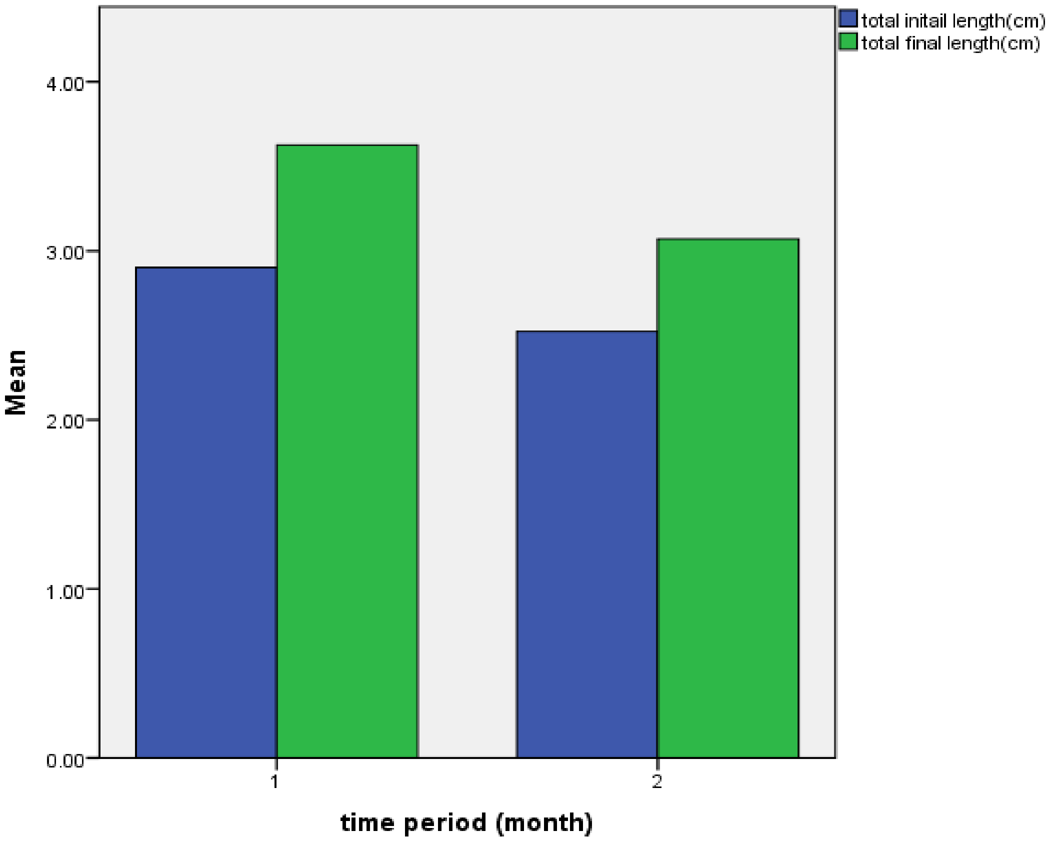

Figure 7. Comparative analysis of feed conversion ratio (FCR) between Aquarium 1 and Aquarium 2

Discussion

The present study demonstrated that dietary treatment significantly influenced the growth

performance of *C. cachius* under controlled aquarium conditions. Fish fed minced chicken meat (Aquarium 1) exhibited greater final total length (3.626 cm) and higher mean weight gain (0.1803 g) than fish receiving commercial fish feed (Aquarium 2), suggesting that the chicken meat diet provided more suitable nutrients for somatic growth. High-protein diets have been widely reported to enhance tissue development and improve growth performance in freshwater fishes by supplying adequate amino acids for muscle formation and metabolism (NRC, 2011). Similarly, De Silva and Anderson (1995) reported that diet quality and protein availability are among the primary factors determining growth efficiency and production in cultured fish.
Although fish in Aquarium 2 exhibited a significantly higher specific growth rate (SGR), the absolute increase in body length and weight remained greater in Aquarium 1. This difference may be attributed to the mathematical nature of SGR, which is influenced by initial body size, whereas absolute growth more accurately reflects the total biomass produced during the culture period (Jobling, 1994). Feed conversion ratio (FCR) values in both treatments (2.36–2.46) indicated efficient feed utilization and were within acceptable ranges for freshwater cyprinid fishes, demonstrating that both diets adequately supported fish maintenance and growth. Feed conversion efficiency is considered a reliable indicator of dietary quality and culture performance in aquaculture systems (Tacon & Metian, 2015). The strong positive correlation between final length and body weight ($r = 0.725$, $p < 0.001$) indicates that increases in body length were accompanied by proportional increases in body weight. Similar positive length–weight relationships have been reported for many freshwater fishes and are widely recognized as indicators of healthy growth and favorable environmental conditions (Froese, 2006). Length–weight relationships are also valuable tools for evaluating fish condition, nutritional status, and overall population health in both natural and captive environments (Le Cren, 1951).
An important finding of the present study was the 100% survival rate recorded throughout the five-month experimental period. The absence of mortality suggests that the controlled aquarium conditions, including stable temperature, adequate aeration, regular water exchange, and appropriate feeding management, provided a favorable environment for *C. cachius*. Water quality and proper nutritional management are recognized as essential factors influencing fish survival, stress tolerance, and culture success (Boyd & Tucker, 2012). Overall, the findings indicate that *C. cachius* adapts well to captive conditions and possesses considerable potential for ornamental fish culture and cons

Conclusion
The present study documented that *C. cachius* can be successfully cultured under controlled aquarium conditions with excellent survival and satisfactory growth. Fish fed minced chicken meat achieved greater increases in total length and body weight than those fed commercial fish feed, while both diets supported efficient feed utilization and resulted in 100% survival. The significant positive correlation between body length and weight confirms normal and healthy growth under captive conditions. These findings provide baseline information for developing feeding protocols and captive management practices for *C. cachius* and support its potential for ornamental fish production, conservation, and small-scale aquaculture in Pakistan. Further studies should investigate formulated high-protein diets, stocking density, and reproductive performance to optimize commercial culture of this species.

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