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Comparative growth performance of major and minor carps of genus *Labeo* in lesser Himalayan region, India

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ABSTRACT

To evaluate the growth performance of Indian major carps (*Labeo catla* and *Labeo rohita*) and minor carp (*Labeo gonius*) in captivity, an experiment was conducted for 90 days. Three different treatment sets (T_1, T_2, and T_3) in FRP tanks (Size. 2.5 m diameter with 4 m^3 water volume) in triplicate with experimental fishes (*L. catla, L. rohita* and *L. gonius*) @ 25 fingerlings m^{-3} with uniform combinations of 1:1 (T_1- *L. catla* and *L. gonius*; T_2- *L. catla* and *L. rohita*, T_3- *L. rohita* and *L. gonius*) were maintained indoor in polycarbonate house. Throughout experimental period, growth parameters viz. weight gain, length gain and specific growth rate were observed. In addition, important water quality parameters viz. water temperature, total dissolved solids, conductivity, dissolvedoxygen and pH were recorded fortnightly and found to be optimum. The statistical analysis showed a significant difference in the weight gain of experimental fish among treatments. The highest weight gain was observed in the experimental fishes of treatment T_1 compared to T_2 and T_3 treatments. The specific growth rate ranged between 0.1 to 0.35% per day. A significant difference in fish survival rate was observed among treatments in which T_1 and T_3 showed better survival than T_2. Overall results showed that the growth performance of *L. gonius* in combination with *L. catla* was best among all while *L. gonius* performed excellent with *L. catla*. The findings of work could provide valuable insights into the development of improved composite aqua farming practices leading to enhanced production and economic upliftment.

Keywords: Economic upliftment, Growth performance, Minor carp, Specific growth rate, Survival rate

Indian fish production heavily relies on the major carp, which make a significant contribution to the country's aquaculture output. Major carp, such as rohu, catla, and mrigal, are widely cultivated and harvested in various regions of India, playing a crucial role in meeting the nation's demand for fish and providing livelihood opportunities for many communities engaged in the fisheries sector (DoF 2022). As aquaculture continues to expand, the demand for high-quality aquaculture feed rises, and as feed costs make up to 60% of the total production expenses (Mohanty 2001, Stankovic *et al*. 2011), sparking concerns over feed availability and cost-effective production are evident.

Composite farming of fish involves cultivating diverse fish species with varying feeding habits in the same pond, allowing for optimal utilization of natural foods from different strata and zones without causing harm to one another (Cairns and Brookfield 2023). The careful selection of other fish species is crucial for the success of such cultural practices, ensuring a harmonious and productive coexistence within the aquatic ecosystem (Hasan *et al*. 2017).

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In recent years, the Indian aquaculture system has embraced integration of fast-growing, high value and popularly accepted species, alongside efforts being taken up to incorporate important indigenous species in the culture system. This strategic inclusion of diverse species has not only resulted in higher production yields (Das and Mishra 2016) but also broadened the range of options available to fish farmers and consumers alike (Kumar *et al*. 2018).

The present study aimed to gauge the growth performance, compatibility and potential benefits of combining kuria labeo (*Labeo gonius),* a minor carp with major carps (*Labeo catla* and *Labeo rohita)* belonging to the *Cyprinidae* family, further diversifying the aquaculture practices and enhance overall fish production in the region.

MATERIALS AND METHODS

The present study was conducted for 90 days from January to April 2023 in circular FRP tanks (Size 4 m^3 each) kept indoors under a polycarbonate house at Instructional Fish Farm, College of Fisheries, G B Pant University of Agriculture & Technology, Pantnagar, Distt. Udham Singh Nagar, Uttarakhand, India. Pantnagar is geographically located at 28°58′ N latitude, 79°25′ E longitude and an altitude of 243.8 m above mean sea level, in the Tarai belt of the Shivalik range of Himalayan foothills (IMD 2015).

Three different treatment sets (T_1, T_2, and T_3) in triplicate with experimental fishes (*L. catla, L. rohita* and *L. gonius*) @ 25 fingerlings m^{-3} in each tank with uniform combinations *of* 1:1 ratio (T_1- *L. catla* and *L. gonius*; T_2- *L. catla* and *L. rohita*, T_3- *L. rohita* and *L. gonius*) were maintained. For the present study, healthy and disease-free fingerlings of experimental fishes were collected from natural water bodies (rivers and reservoirs) of Kumaon region. Before stocking in experimental tanks, the fingerlings were acclimatized. In all three treatments, the fish were fed twice (9-10 a.m. in the morning and 4-5 p.m. in the evening) daily with 35% protein pelleted feed at the rate of 2% body weight. The daily feed rate was slightly adjusted based on its consumption. Fortnightly analysis of physico-chemical water quality parameters viz. water temperature, dissolved oxygen, pH, total dissolved solids and conductivity were done between 9-10 a.m. following the guidelines outlined by APHA (2017) and by use of multiparameter water analyzer (YSI Pro-DSS). Analysis of water quality and growth parameters were completed at the experimental site and in the laboratory of Department of Aquatic Environment Management.

Throughout the experimental period, the length and weight of all fingerlings were recorded fortnightly with precision, rounded to the nearest 0.01 mg and 1 mm, respectively. Additionally, the number of living individuals was documented. The growth performance indicators, including length gain, weight gain, specific growth rate (SGR) and survival rate, demonstrated by fingerlings fed with the experimental diet, were calculated using the formulas given by Rombenso *et al.* (2022):

$$\text{Weight gain (\%)} = \frac{\text{Final weight (g)} - \text{Initial weight (g)}}{\text{Initial weight (g)}} \times 100$$

$$\text{Length gain (\%)} = \frac{\text{Final length (cm)} - \text{Initial length (cm)}}{\text{Initial length (cm)}} \times 100$$

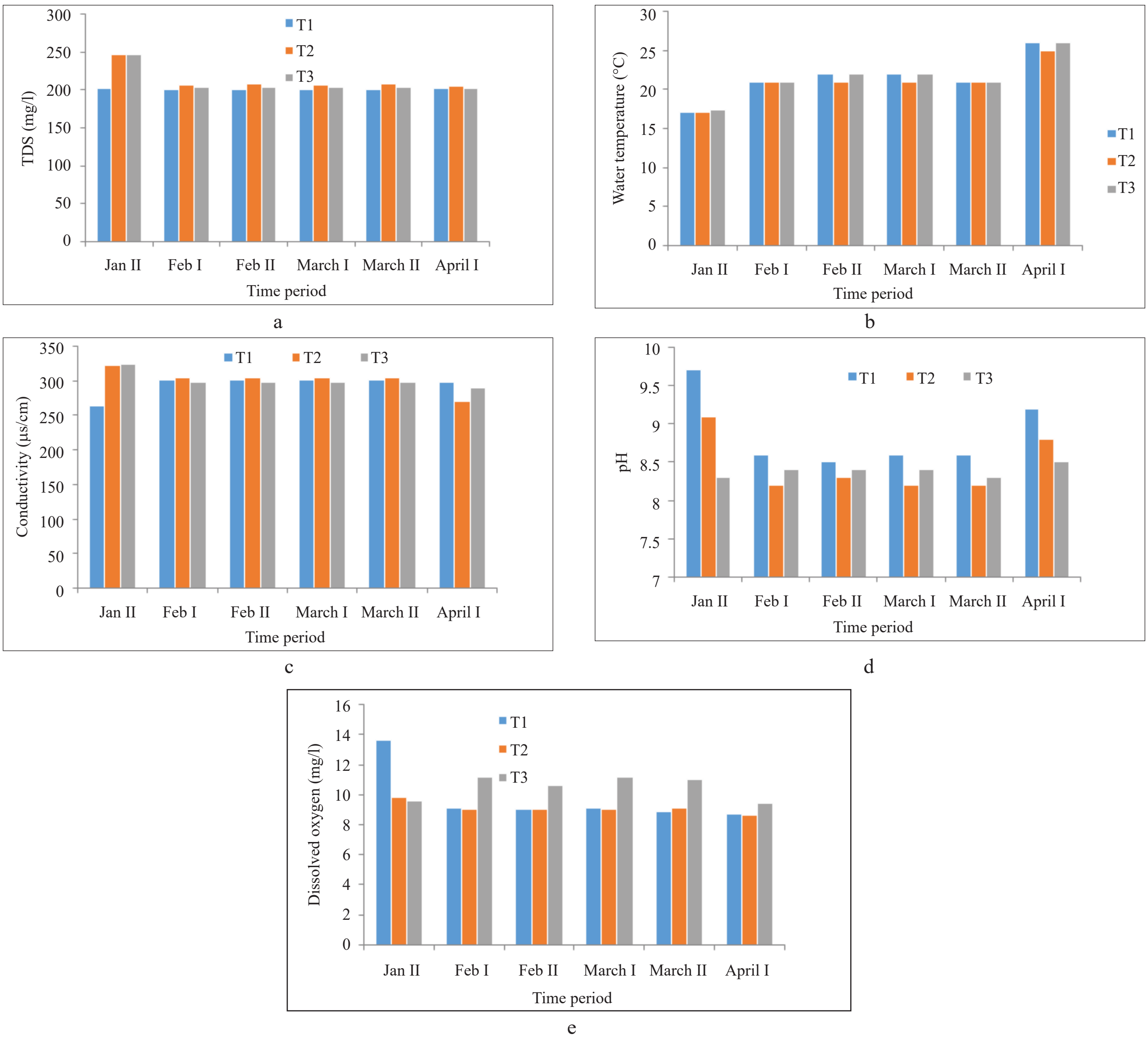

Fig. 1. (a-e) Fortnightly variation in water quality parameters

$$\text{Specific growth rate}(\%/\text{day}) = \frac{[\ln(\text{Final weight}) - \ln(\text{Initial weight})]}{\text{Culture period(day)}} \times 100$$

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

Growth parameters and morphological indices as final body weight (FBW, g) final body length (FBL, cm) length gain (LG, cm) weight gain (WG, g) and condition factor (K)

Where calculated as follow:

LG, cm = Final body length -Initial body length (IBL)

WG, g = Final body weight -initial body weight

Condition factor (K) was estimated using: $K= W*100/ L^3$ (Gesto *et al.* 2017),

Where, W is the total body weight of fish, and L is the total length.

For each replicate of every treatment, average values of length, weight, specific growth rate and survival were computed, along with their corresponding standard error (SE) values. Differences in the average values of length, weight, specific growth rate, and survival among the experimental treatments were analyzed using one-way ANOVA at significance level of 0.05.

RESULTS AND DISCUSSION

The mean values of monthly variation of various water quality parameters such as water temperature, dissolved oxygen, pH, total dissolved solids and conductivity is presented treatment-wise (Fig. 1. a-e).

During the experimental period, fortnightly monitoring of water quality parameters revealed maintenance of the optimal conditions across all the three treatments. The water temperature varied between 17.1 (T_1 and T_2 during January II) to 26.0°C (T_1 and T_3 during April I) in the experimental tanks with an average value of 21.5°C. Although the fish can tolerate a wide variety of water temperatures, any abrupt or dramatic changes in water temperature has a significant influence on fish's physiology (Kiruthika *et al.* 2017). Total dissolved solids ranged between 200.5 (T_1 during March II) and 246.5 mg/L (T_2 during January II) with an average value of 210.4 mg/L. For diversified fish culture, a maximum TDS value of 400 mg/L is acceptable (James 2000). Conductivity levels ranged between 264.3 (T_1 during January II) and 323.4 µS/cm (T_3 during January II) with a mean value of 297.9 µScm^{-1}. The electrical conductivity of a freshwater body that supports fisheries should be between 150 and 500 µScm^{-1} (James 2000). The pH levels consistently remained above seven, and ranged between 8.2 (T_2 during February I and March I, II) and 9.7 (T_1 during January II) with an average value of 8.6 throughout the study period. The best pH for fish has been discovered to be neutral to slightly alkaline (Summerfelt 2000). Higher levels of dissolved oxygen ranging between 8.6 (T_2 during April I) and 13.6 mg/L (T_1 during January II) with an average value of 9.8 mg/L were observed as the tanks were facilitated with an aeration system. Dissolved oxygen (DO) is a key water quality measure for existence of aquatic life (Najah *et al.* 2014). The results of the water quality parameters were found to be similar to the results obtained by Soranganba and Singh (2018), Kumar *et al.* (2019) and Chandra *et al.* (2022).

Treatments demonstrated nearly identical fluctuations in important water quality parameters viz. water temperature, total dissolved solids, conductivity, pH and dissolved oxygen among the treatments and were in optimal range throughout the experimental period. This similarity can be attributed to the adoption of comparable management practices in the treatments. All water quality parameters fell within the acceptable range for the cultivation of tropical fish as suggested by Verma *et al.* (2022). Water quality has a direct impact on the growth of any fish species, which can determine the success of aquaculture production (Ebeling *et al.* 2006, Sharma *et al.* 2017). Das *et al.* (2020) observed water quality variation during the study of growth performance and compatibility of *Osteobrama belangeri* with catla and rohu and no significant changes in water quality between different treatments were observed throughout the study period.

The statistical analysis of the result shows that there was a significant difference ($p<0 .05$) in the weight gain of experimental fish among treatments. The highest weight gain was observed in the experimental fishes of T_1 as compared to T_2 and T_3 treatments (Table 1). The specific growth rate (SGR) ranged between 0.1 and 0.35% day^{-1}. The highest growth rate was observed for catla in T_1. A significant difference ($p<0.05$) in survival rate was also observed among treatments in which T_1 and T_3 (>90%) fishes showed better survival than T_2 (<90%). Kuria labeo (*L. gonius*) showed a significantly higher survival rate (96%) than other two species. Similar to weight gain, the length gain was also higher in catla and highest in T_1.

The growth curves of weight gain of all the treatments T_1, T_2 and T_3, are depicted in Fig. 2. Growth curves showed elevated growth of catla in T_1 and rohu in T_3. Kuria labeo showed a similar growth curve pattern in both T_1 and T_3.

In treatment T_1 where *L. gonius* and *L. catla* were grown combinedly, the latter showed a positive increase in the growth. The *L. catla* exhibited a greater net weight gain when paired with *L. gonius* (T_1) than with *L. rohu* (T_2). On the other hand, the combination of both *L. rohu* and *L. gonius* displayed limited weight gain when kept together in T_3. This phenomenon could be attributed to the sharing of the same water column by these two species. Notably, in tank-based culture systems, studies have shown similar favorable outcomes with the pairing of rohu and tilapia (Rahman *et al.* 2021). Earlier, investigations into the compatibility of the minor carp tilapia (*Osteobrama belangeri*) with Indian major carps (IMCs) have also indicated harmonious coexistence and improved growth when reared along with Catla and Rohu within a polyculture framework (Das *et al.* 2020).

The survival rate in treatment T_1 was higher as compared to other treatments. The water quality remained almost similar in all three treatments proving that the combination

Table 1. Yield attribute of *Labeo gonius* with major carps

Treatment	Species	IBL (cm)	FBL (cm)	IBW (g)	FBW (g)	Weight gain (%)	Length gain (%)	SGR (%)	Survival rate (%)	K
T1	*Labeo gonius*	12.79±0.30	12.91±031	19.63±1.08	24.3±1.01	23.79	0.94	0.10	96	1.03
	Labeo catla	14.23±0.70	17.46±0.72	32.45±429	68.3±7.35	110.47	22.72	0.36	94	1.16
T2	*Labeo catla*	14.23±0.70	17.35±0.53	32.45±4.29	60.8±5.32	87.36	17.03	0.30	84	1.13
	Labeo rohita	13.40±0.51	15.56±0.36	23.91±2.48	44.0±1.90	84.02	16.12	0.29	82	1.22
T3	*Labeo rohita*	13.40±0.51	14.95±0.23	23.91±2.48	39.6±1.72	65.62	11.57	0.24	90	1.23
	Labeo gonius	12.79±0.30	13±0.23	19.63±1.08	24.2±1.45	23.28	1.64	0.10	96	1.07

of species affects their survival. In tilapia (*O. niloticus*), no significant difference in growth performance and survival rate was reported when maintained optimum water quality parameters (Abd El-Hack *et al*. 2022).

The *L. catla* showed higher weight gain, length gain and SGR with *L. gonius* while *L. rohu* showed low weight gain, length gain and SGR with the same combination. This depicts that *L. gonius* had no niche or feeding overlapping with *L. catla*, while some competition might exist between *L. rohita* and *L. gonius* for niche and food. Similar results were depicted in *L. fimbriatus* in combination with IMCs and Silver carp where it was indicated that *L. fimbriatus* had no overlapping for niche and food with surface feeder carp such as catla and silver carp (Jena *et al*. 2015).

The compatibility and growth performance of Pegnba, *Osteobrama belangeri* with catla or rohu and control as rohu-catla combination was studied by Das *et al*. (2020). The Pengba was observed to show no adverse effect on survival of either catla or rohu while a better growth of both combinations compared to control (rohu and catla) was recorded. The competition of Pengba was less with either species than interspecific competition among them. The results also depicted better compatibility of catla with pengba than rohu. Similar results were observed in the present study where the combination of catla and kuria labeo performed better than other treatments. The growth curve pattern showed sudden elevation during the third month of the experiment which might be due to enhanced feeding rate and seasonal effect as the system was semi-intensive. Similar results of elevated growth curves of major carp were reported with minor carp *O. belangeri* (Das *et al*. 2020).

To understand growth performance and compatibility in polyculture systems, Kumar *et al*. (2018) studied the combination of pacu with catla, rohu and mrigal. No significant effect of Pacu on the survival of any Indian major carp was recorded while a possibility of feeding and niche competition between pacu and rohu had been observed (Kumar *et al*. 2018).

The combined growth performance of *Labeo gonius* and *Labeo catla* demonstrated the highest overall growth results compared to other combinations. Minor carp species have shown excellent compatibility when co-cultured with major carp species in aquaculture systems. In particular, *Labeo gonius* exhibited excellent performance when paired with *Labeo catla*. This compatibility allows for an efficient utilization of available space and resources, leading to enhanced productivity and profitability in aquaculture operations. The research findings offer valuable insights into the advancement of integrated aquaculture practices for these species, which can contribute to increased production and economic development in the aquaculture sector.

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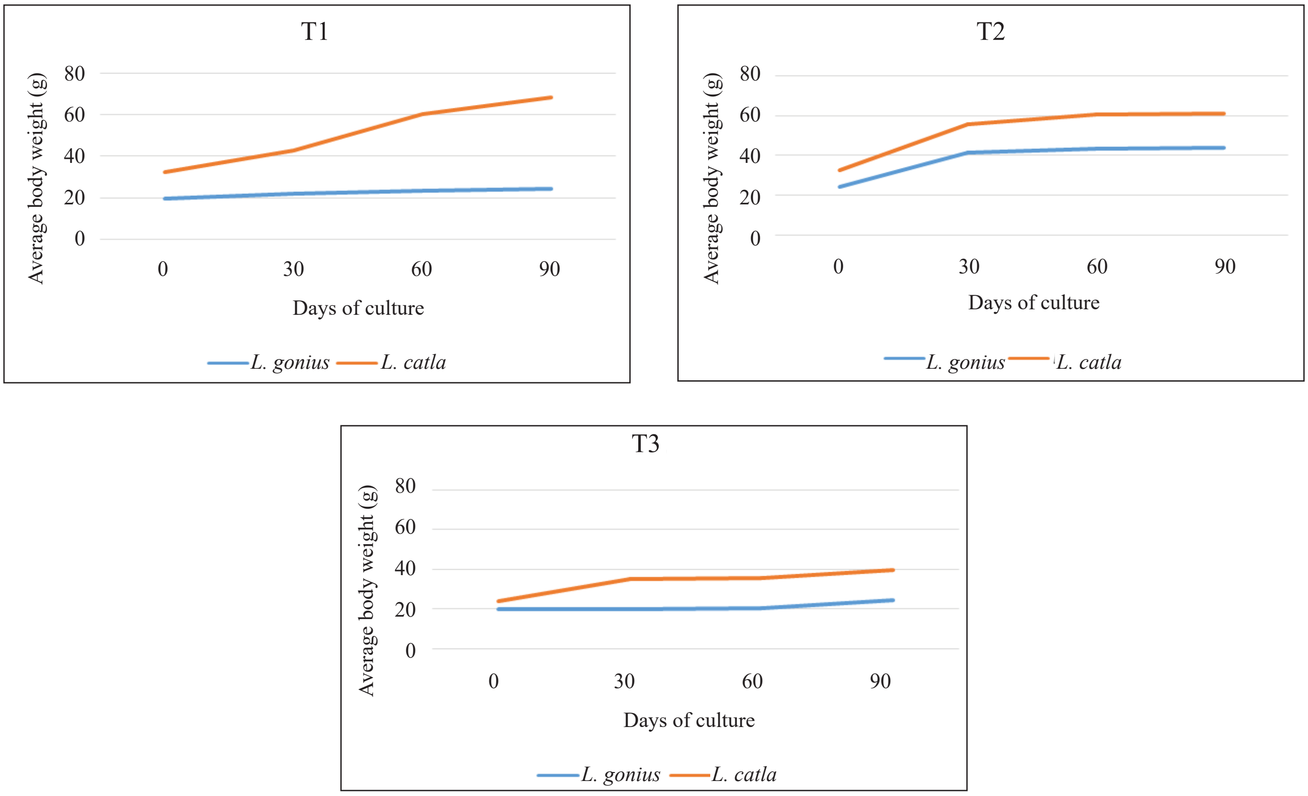

Fig. 2. Growth curves of experimental fishes in different treatments

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