

Effect of Water Temperature on Growth Performance and Feed Intake of Labeo Rohita and Catla Catla

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Abstract

The impact of temperature on the feed conversion, weight gain and overall growth of two widely cultured freshwater fish species of India *Labeo rohita* and *Catla catla* was assessed in the present study. *Labeo rohita* attained significantly higher ($P < 0.05$) body weight gain at water temperature of 28°C, followed by the same at water temperature of 32°C, 36°C, 24°C and 20°C, respectively. The fish reared at 28°C water temperature showed the best feed intake value (86% consumption), followed by those maintained at 32°C, 36°C, 24°C and 20°C, respectively. *Catla catla* also attained significantly higher ($P < 0.05$) body weight gain at water temperature of 28°C. Higher body weight was also observed at temperature of 32°C and 24°C, compared to water temperature of 20°C and 36°C, respectively. The fish reared in 28°C water temperature showed the best feed intake value (93% consumption). Relative weight gain was found to decrease at water temperature above 28°C irrespective of Catla or Rohu. The percentage body weight gain decreased significantly in Rohu than Catla from water temperature of 28°C. Moreover, feed intake was found decreased at higher temperature; but significant variation was not found between the species. The present model provides a basis for the aqua culturists to optimise release timing of fish seeds and feeding of fish to achieve the maximum weight gain, productivity and economic sustainability.

Introduction

Temperature variations as a result of climate change, are now been considered as the major threat to biodiversity and aquaculture by lowering fish productivity worldwide [1]. The environmental temperature is the key factor that alters the various aspects of biology, distribution, behaviour, fitness, and performances of fish [2, 3]. Reported that seasonal and climate changes can directly impact the thermal tolerance as well as life of the organism. Though thermal preferences are species-specific and genetically inherent [4]. But it also impacts the weight gain, food availability, host- pathogen interaction, and water quality affecting the fish production [5]. The increase or decrease in temperature beyond optimum level cause physiological changes ultimately leading to growth retardation and death of an organism. Climate change may lead to creation of physical or physiological barriers [6]. That might limit the habitat's shift of independently mobile organisms and in turn leads to loss of genetic diversity [6]. Fish have very limited options to adopt to the changes by moving to a more appropriate habitat or new environmental conditions [7]. Though most of the species have ability to modify their thermal tolerance limit and adjust to the new temperature regimes by modifying physiological functioning through acclimation [8]. Temperature rise is beneficial for aquaculture production to a certain range, as it enhance metabolism and growth rate, along with reduction in the maturation or culture period [9]. However, increase in temperature beyond the optimal limit can surge metabolic stress, increase the oxygen demand [10] and negatively impact the immunity [11]. Moreover reported that the expected 1-4°C rise in temperature due to global warming may affect aquatic ecosystems over the following century [12]. Enhanced temperature may also create physiological, ecological, and operational changes in inland fish and fish production system. Like higher temperature, suboptimal temperature also impair the health of fish by effecting metabolism, by slowing or shutdown of immune response mechanism and increasing susceptibility to pathogens [11]. Freshwater aquaculture in India is mainly contributed by the Indian Major carps specially *Labeo rohita* and *Catla catla* which together contribute the major share (87%) of the inland fish production in India [13]. The present investigation was carried out to study the impact of temperature on the feed conversion, weight gain and overall growth of *L. rohita* and *C. catla* the two widely cultured freshwater fish species of India.

Materials and methods

Experimental site

The experiment was performed at the wet lab of Regional research station- Rahara, West Bengal of Indian Council of Agricultural Research-Central Institute of Freshwater Aquaculture (ICAR-CIFA).

Fish species

Total 200 numbers of fingerlings of rohu (*Labeo rohita*) weighing 4.11 ± 0.47 g and Catla (*Catla Catla*) weighing 4.86 ± 0.73 g were procured from ICAR-CIFA, India. On receipt, the fish were acclimatized separately for 15 days prior to the experiment in the fibre glass reinforced plastic tanks (FRP) of 1000 L capacity. The fish were fed with commercial floating feed (Grow finTM Starter feed code: 2432512) containing 32% protein, 5% fat, 5.5% fibre and 11.5% moisture at 4% of body weight of fish. Continuous aeration was provided and 30% replacement of water with fresh bore well water was done daily to avoid deposition of nitrogenous wastes.

Experimental design

The temperature (20°C, 24°C, 28°C, 32°C and 36°C) was maintained using thermostats. Total 10 numbers of the acclimatized fingerlings were subjected to each of the temperature regimes of 20°C, 24°C, 28°C, 32°C and 36°C in FRP tanks containing 200 L water in triplicates. The water temperature was measured using Labman Multi-parameter water quality meter LMMP-30, India. The water parameters were examined on the initial day of the experimentation and on every alternate day interval till the final day of sampling. The fish were raised in their respective tanks for 7 weeks. Sampling was done on initial day (0d) and the end of the experimental period (49 d) and feed intake and weight gain of fish (g) were recorded. The survival

percentage (No. of fish survived post experimental period/Initial no. of fishes stocked x 100), weight gain (Final weight-Initial weight/Initial weight) and feed consumption (Feed given-Feed consumed/Feed given x100) of *Labeo rohita* and *Catla catla* was measured post experimentation period.

Data analysis

Data were expressed as mean \pm standard deviation. The data were analyzed by analysis of variance (ANOVA) [14]. Statistical software SPSS version 16.0 was used to analyse data with the levels of significance at $P < 0.05$ Figure 1.

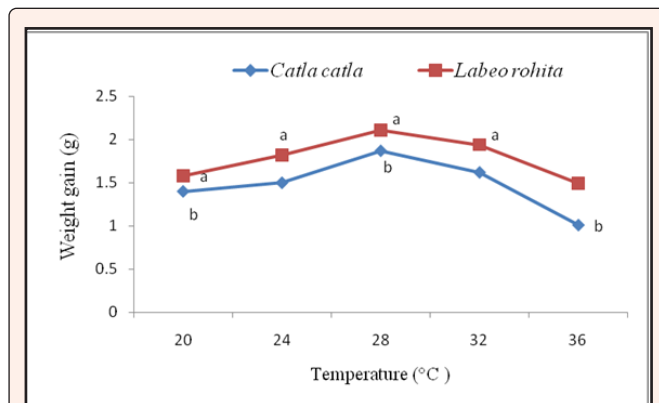


Figure 1: Weight gain of *Labeo rohita* (Rohu) and *Catla catla* (Catla) with increasing temperature. a, b: Markers showing common alphabets as superscript differs significantly ($P < 0.05$)

Results

Feed intake and weight gain of *Labeo rohita* in relation to temperatures

Labeo rohita attained significantly higher ($P < 0.05$) body weight gain (2.11 ± 0.007 g) under water temperature of 28°C. This was followed by 1.94 ± 0.003 g and 1.49 ± 0.009 g weight gain under water temperature of 32°C and 36°C, whereas, the weight gain was 1.82 ± 0.008 g and 1.58 ± 0.006 g at water temperature of 24°C and 20°C, respectively (Fig.1). The fish reared in 28°C water temperature showed the best feed intake value (86% consumed), followed by those maintained at 32°C (75% consumed), 36°C (55% consumed), 24°C (64% consumed) and 20°C (59% consumed), respectively (Figure 2).

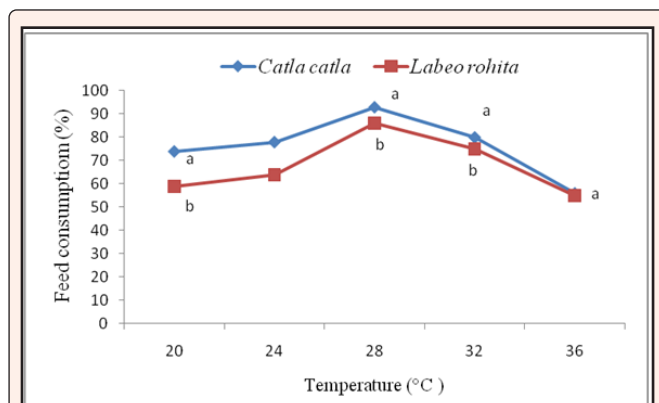


Figure 2: Feed consumption of *Labeo rohita* (Rohu) and *Catla catla* (Catla) with increasing temperature. a, b: Markers showing common alphabets as superscript differs significantly ($P < 0.05$).

Feed intake and weight gain of *Catla catla* in relation to temperature

Catla catla attained significantly higher ($P < 0.05$) body weight gain (1.87 ± 0.007 g) under water temperature of 28°C. This was followed by 1.62 ± 0.008 g and 1.50 ± 0.009 g body weight gain under water temperature of 32°C and 24°C, respectively, whereas the

weight gain was 1.40 ± 0.008 g under water temperature of 20°C, and 1.01 ± 0.006 g under water temperature of 36°C (Fig.1). The fish reared in 28°C water temperature showed the best feed intake value (93% consumed), followed by those maintained at 32°C (80% consumed), 24°C (78% consumed), 20°C (74% consumed) and 36°C (56% consumed), respectively (Figure 2). Relative weight gain was found to decrease at temperature above 28°C irrespective of Catla or Rohu. The percentage body weight gain also decreased significantly in Rohu than Catla from water temperature of 28°C (Fig.3). Moreover, feed intake was found decreased at higher temperature; but significant variation was not found between the species Figure 3.

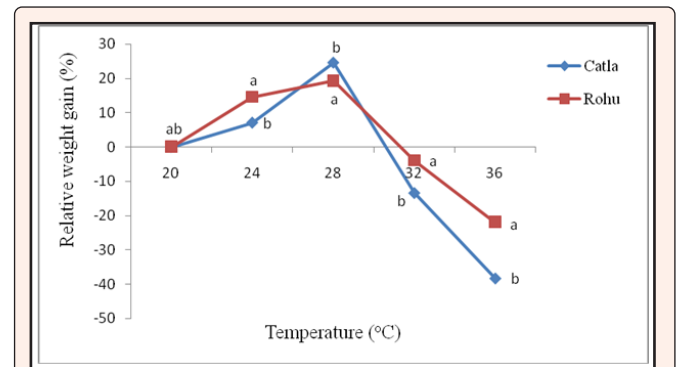


Figure 3: Relative weight gain of *Labeo rohita* (Rohu) and *Catla catla* (Catla) with increasing temperature; a, b: Markers showing common alphabets as superscript differs significantly ($P < 0.05$).

Discussion

Every fish species has different optimum temperature for growth and survival. With fluctuations in environmental temperature morphological, biochemical and endocrinological alterations have been evidenced in fish leading to increasing demand of energy. Survival rate and growth of a fish depends upon the temperature and other environmental factors of aquatic environment where fish live. In the present study fingerlings of *Labeo rohita* and *Catla catla* were selected and treated with varied temperatures ranging from 20°C to 36°C in which 100% survivality were observed in all temperature regime. In the present study, *Labeo rohita* attained significantly higher body weight gain at water temperature of 28°C followed by the weight gain at 32°C and 24°C, respectively. The lowest weight gain was reported at water temperature of 36°C. At temperature of 36°C, no significant difference was observed in the weight gain of *Labeo rohita*, as compared to 20°C. Contrary to the present observation [15]. Reported significant increase in the growth rate of *L. rohita* at temperature range from 32 °C to 34°C and there after it decreased at 35 °C. Moreover [16]. Recorded 31°-33°C as the optimum temperature range for growth of *L. rohita*. However, the present study reported 24°-32°C as the optimum temperature for weight gain of *L. rohita*. Interestingly, in the present study, the same trend in weight gain was also noticed in [17, 18]. Reported better development of *Catla* fry at a temperature range of $30 \pm 2^\circ\text{C}$ to $32 \pm 1^\circ\text{C}$, whereas [19]. Observed that carps thrive well in the temperature range of 18.3°C to 37.8°C . Fish growth is temperature dependent and generally increase with temperature to an optimum level before decreasing again [20]. This optimum growth temperature varies with species.

Fish requires diet as a fuel for physical activities and body maintenance. Aquaculturists desire maximum growth of fish by development of muscle tissue with minimum feed for the economic benefit. Hence, feeding management plays an important role in fish farming for making it efficient and profitable for fish farmers. Feed consumption (%) was scientifically monitored throughout the study period. *L. rohita* and *C. catla* reared in 28°C water temperature showed the best feed intake followed by those maintained at 32°C, 24°C, 20°C and 36°C, respectively. The highest feed consumption was reported in *C. catla* as compared to *L. rohita*. This may be due to the higher adaptability of *C. catla* towards higher temperature as reported by (Sharma et al. (2014) [17]. The food consumption and wet weight gain play an important role in the increase or decrease of FCR (Feed conversion ratio) as noticed by Mishra et al. (2019) [15]. They also mentioned better feed conversion ratio of *L. rohita* maintained at 24-26°C, which may be attributed to the increased feed intake and capability to spare more nutrients for growth of the fish after fulfilling the basic maintenance requirements. The data presented in our study may not reflect the exact growth rates of fish under natural system, although the present result demonstrate the weight gain of the two most important carps with relation to water temperature of 20°C to 36 °C. In this global warming scenario, as water availability



during the summer when decrease in precipitation and increase in temperature is a major issue, the present model provides a basis for the aqua culturists to optimise release timing of fish seeds and feeding of fish to achieve the maximum weight gain, productivity and economic sustainability [21].

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