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Growth Performance and Survival Rate of Mahseer (Tor spp.) Cultured under Different Temperature Conditions

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ABSTRACT

Water temperature is a critical environmental factor influencing growth performance, feed utilization, and survival of freshwater fish, particularly ectothermic species such as mahseer (Tor spp.). This study aimed to evaluate the effects of different rearing temperatures on the growth performance and survival rate of mahseer cultured under controlled laboratory conditions. Juvenile mahseer with an initial weight of 3–5 g were reared for 60 days under three temperature treatments: 22 ± 1 °C, 26 ± 1 °C, and 30 ± 1 °C, using a completely randomized design with three replicates per treatment. Fish were fed a commercial diet containing 32–35% crude protein at a feeding rate of 3–5% of biomass per day. Growth parameters, feed conversion ratio (FCR), survival rate (SR), and water quality were monitored throughout the experiment. The results showed that water temperature significantly affected growth performance, feed efficiency, and survival of mahseer ($p < 0.05$). Fish reared at 26 °C exhibited the highest final weight, weight gain, specific growth rate, and the lowest FCR, indicating optimal feed utilization at this temperature. Lower growth performance was observed at 22 °C, likely due to reduced metabolic activity, while exposure to 30 °C resulted in decreased growth efficiency and survival, suggesting thermal stress. Survival rate remained above 80% across all treatments, with the highest survival recorded at 26 °C. In conclusion, rearing temperature around 26 °C is optimal for juvenile mahseer culture under laboratory conditions. These findings provide practical guidance for temperature management in mahseer aquaculture and support the development of sustainable culture and ex-situ conservation strategies for Tor spp.

Keywords: *mahseer, Tor spp., water temperature, growth performance, survival rate, aquaculture*

INTRODUCTION

Mahseer (*Tor* spp.) is one of the most important freshwater fish groups distributed across South and Southeast Asia, known for its high economic value, ecological significance, and cultural importance in riverine communities (Pinder et al., 2019). In many regions, mahseer populations have declined sharply due to overfishing, habitat fragmentation, river regulation, pollution, and land-use change (Walton et al., 2017; Pinder et al., 2019). These pressures have raised serious concerns regarding the long-term sustainability of wild mahseer stocks.

Aquaculture has been widely promoted as a strategic approach to reduce exploitation pressure on natural fish populations while supporting food security and rural livelihoods (FAO, 2017). For mahseer, captive breeding and culture are increasingly recognized as essential tools for both conservation and sustainable utilization (Ng, 2004; FAO, 2017). However, the expansion of mahseer aquaculture remains limited by biological constraints, including relatively slow growth rates and sensitivity to environmental conditions (Ingram et al., 2005).

Among environmental factors, water temperature plays a central role in regulating fish metabolism, feeding activity, digestion efficiency, growth performance, and survival (Jobling, 1997; Volkoff & Rønnestad, 2020). As ectothermic organisms, fish depend strongly on ambient temperature to control physiological processes. Suboptimal temperatures can reduce feed intake and growth, while extreme temperatures may induce stress, suppress immune function, and increase mortality (Brett, 1971; Jobling, 1997).

Previous studies on mahseer species have demonstrated that temperature significantly influences growth performance and feed utilization. Experimental studies on *Tor tambroides*, *Tor soro*, and *Tor putitora* have reported that moderate temperature ranges generally support optimal growth and survival, whereas temperatures outside the optimal range negatively affect performance (Das et al., 2018; Muchlisin et al., 2016; Rathod et al., 2022). These studies indicate that thermal tolerance and optimal temperature ranges may vary among species, life stages, and geographic origins.

In addition to growth and survival, temperature has been shown to affect physiological and immune responses in mahseer. Elevated or fluctuating temperatures can alter hematological parameters, enzymatic activity, and stress-related biochemical indicators, potentially increasing susceptibility to disease under culture conditions (Rathod et al., 2022). Such responses highlight the importance of identifying suitable and stable temperature regimes for hatchery and nursery operations.

Malaysia has become an important center for mahseer research, particularly on taxonomy, genetics, hatchery technology, and conservation-oriented aquaculture (Ng, 2004; Redzwan et al., 2022). Genetic studies emphasize that different mahseer populations may respond differently to environmental conditions, including temperature, underscoring the need for controlled experimental evaluations (Chew et al., 2021).

Despite increasing research interest, information on the combined effects of different rearing temperatures on growth performance and survival rate of mahseer under strictly controlled laboratory conditions remains limited. Most existing studies focus on single temperature ranges or specific life stages, leaving gaps in comparative experimental data that are directly applicable to aquaculture management.

Therefore, this study aims to evaluate the effects of different water temperature conditions on the growth performance and survival rate of mahseer (*Tor* spp.) cultured under controlled laboratory conditions. The results are expected to provide scientific guidance for temperature management in mahseer aquaculture and contribute to ex-situ conservation strategies for this ecologically and economically important freshwater fish.

MATERIALS AND METHODS

Experimental Site and Duration

The experiment was conducted under controlled laboratory conditions at the Aquaculture Laboratory, Faculty of Fisheries and Food Science, Universiti Malaysia Terengganu, Malaysia. The study was carried out for a period of 60 days, including acclimation and experimental phases.

Experimental Fish

Juvenile mahseer (*Tor* spp.) were used as experimental animals. Fish were obtained from a certified hatchery and transported to the laboratory under aerated conditions. At the beginning of the experiment, the fish had an average initial total length of 5–7 cm and an average body weight of 3–5 g. Prior to the experiment, fish were acclimated for 7 days under laboratory conditions.

Experimental Design

A completely randomized design (CRD) was applied with three different water temperature treatments, each with three replicates:

- T1: 22 ± 1 °C
- T2: 26 ± 1 °C
- T3: 30 ± 1 °C

Each replicate consisted of a glass aquarium with a working volume of 80 L, stocked with 15 fish per aquarium. Water temperature was controlled using submersible heaters and monitored daily using a digital thermometer.

Rearing Conditions and Feeding Management

All aquaria were supplied with continuous aeration to maintain dissolved oxygen levels. Fish were fed a commercial pellet diet containing 32–35% crude protein. Feeding was carried out twice daily (09:00 and 17:00) at a feeding rate of 3–5% of total biomass per day, adjusted biweekly based on sampling results.

Uneaten feed and fecal matter were removed daily by siphoning. Partial water exchange (20–30%) was conducted every two days to maintain water quality.

Water Quality Monitoring

Water quality parameters were monitored throughout the experiment. Temperature was recorded daily, while pH and dissolved oxygen (DO) were measured twice a week using a portable water quality meter. The observed ranges during the experiment were maintained within acceptable limits for mahseer culture.

Growth Performance and Survival Parameters

Fish were sampled every two weeks to measure growth parameters. The following variables were calculated:

- Weight Gain (WG, g)
- Specific Growth Rate (SGR, % day^{-1})
- Feed Conversion Ratio (FCR)
- Survival Rate (SR, %)

Standard equations commonly used in aquaculture studies were applied to calculate these parameters.

Statistical Analysis

All data were expressed as mean ± standard deviation (SD). Data were tested for normality and homogeneity of variance prior to analysis. Differences among temperature treatments were analyzed using one-way analysis of variance (ANOVA). When significant differences were detected ($p < 0.05$), Tukey's post hoc test was applied to determine pairwise differences among treatments. Statistical analyses were performed using SPSS software.

RESULTS AND DISCUSSION

Growth Performance

The growth performance of mahseer (*Tor* spp.) was significantly influenced by different rearing temperature conditions ($p < 0.05$). Fish reared at 26 ± 1 °C exhibited the highest final weight, weight gain, and specific growth rate (SGR), followed by those maintained at 22 ± 1 °C, while the lowest growth performance was observed at 30 ± 1 °C.

The superior growth observed at 26 °C indicates that this temperature is closer to the optimal thermal range for juvenile mahseer under laboratory conditions. At this temperature, metabolic processes, digestion efficiency, and feed utilization are likely balanced, resulting in efficient energy allocation toward somatic growth. Similar findings have been reported in previous studies on mahseer and other tropical freshwater fish, where moderate temperatures supported optimal growth performance (Jobling, 1997; Das et al., 2018; Muchlisin et al., 2016).

In contrast, lower growth at 22 °C may be attributed to reduced metabolic activity and feeding efficiency at cooler temperatures. Although fish remained active and healthy, energy utilization for growth was likely slower. Conversely, exposure to 30 °C appeared to induce thermal stress, increasing maintenance metabolism and reducing energy available for growth. Elevated temperatures have been widely reported to negatively affect growth once species-specific thermal thresholds are exceeded (Brett, 1971; Volkoff & Rønnestad, 2020).

Table 1. Growth Performance of Mahseer (*Tor* spp.) Cultured at Different Water Temperatures

Temperature (°C)	Initial Weight (g)	Final Weight (g)	Weight Gain (g)	SGR (% day^{-1})
22 ± 1	4.10 ± 0.12	8.45 ± 0.38^{b}	4.35 ± 0.26^{b}	1.82 ± 0.09^{b}
26 ± 1	4.08 ± 0.10	10.92 ± 0.44^{a}	6.84 ± 0.31^{a}	2.36 ± 0.11^{a}
30 ± 1	4.12 ± 0.11	7.96 ± 0.41^{c}	3.84 ± 0.29^{c}	1.65 ± 0.08^{c}

Values are presented as mean ± SD (n = 3). Different superscript letters within the same column indicate significant differences among treatments ($p < 0.05$).

Feed Conversion Ratio (FCR)

Feed conversion ratio differed significantly among temperature treatments ($p < 0.05$). The lowest (best) FCR was recorded at 26 °C, indicating more efficient feed utilization at this temperature. Higher FCR values were observed at 22 °C and 30 °C, suggesting suboptimal feed conversion under cooler and warmer conditions.

Efficient feed conversion at moderate temperatures reflects optimal digestive enzyme activity and nutrient assimilation. Previous studies have demonstrated that water temperature strongly affects gastric evacuation rate and enzyme kinetics in fish, which directly influence feed conversion efficiency (Jobling, 1997; Volkoff & Rønnestad, 2020). The present findings confirm that inappropriate thermal conditions may lead to increased feed wastage and reduced aquaculture efficiency in mahseer culture.

Table 2. Feed Conversion Ratio (FCR) and Survival Rate (SR) of Mahseer (*Tor* spp.)

Temperature (°C)	Feed Conversion Ratio (FCR)	Survival Rate (%)
22 ± 1	1.68 ± 0.07^{b}	88.9 ± 3.5^{a}
26 ± 1	1.32 ± 0.05^{a}	93.3 ± 2.9^{a}
30 ± 1	1.89 ± 0.09^{c}	82.2 ± 4.1^{b}

Values are mean ± SD. Different superscript letters indicate significant differences among temperature treatments (ANOVA, $p < 0.05$).

Survival Rate

Survival rate (SR) of mahseer juveniles was high across all treatments, exceeding 80%, indicating that the experimental conditions were generally suitable for fish rearing. However, statistically significant differences were detected among treatments ($p < 0.05$), with the highest survival observed at 26 °C, followed by 22 °C, and the lowest survival at 30 °C.

The reduced survival at higher temperature may be associated with thermal stress, increased oxygen demand, and potential suppression of immune responses. Elevated temperatures are known to compromise physiological stability and increase susceptibility to stress-related mortality in freshwater fish (Rathod et al., 2022). Conversely, stable survival at moderate temperatures suggests that mahseer juveniles possess good adaptability when reared within their optimal thermal range.

Water Quality Conditions

Throughout the experimental period, water quality parameters remained within acceptable ranges for mahseer culture. Dissolved oxygen levels were maintained above 5 mg L^{-1}, and pH values ranged between 6.5 and 7.5. These conditions minimized confounding effects of water quality and ensured that observed differences in growth and survival were primarily driven by temperature treatments.

Maintaining stable water quality is essential when assessing temperature effects, as interactions between temperature, dissolved oxygen, and metabolic demand can strongly influence fish performance. The controlled laboratory setup used in this study effectively isolated temperature as the main experimental factor.

Table 3. Water Quality Parameters During the Experiment

Parameter	22 °C	26 °C	30 °C
Temperature (°C)	22.0 ± 0.6	26.1 ± 0.5	30.2 ± 0.7
Dissolved Oxygen (mg/L)	6.8 ± 0.4	6.5 ± 0.3	5.9 ± 0.4
pH	7.1 ± 0.2	7.0 ± 0.3	6.8 ± 0.2

Implications for Mahseer Aquaculture and Conservation

The results of this study demonstrate that water temperature plays a critical role in determining growth performance, feed efficiency, and survival of mahseer under controlled conditions. The superior performance observed at 26 °C suggests that this temperature range is suitable for juvenile mahseer culture in hatchery and nursery systems.

From an aquaculture perspective, identifying optimal temperature conditions can improve production efficiency, reduce feed costs, and minimize mortality. From a conservation standpoint, successful temperature-managed culture systems can support ex-situ conservation programs and stock enhancement initiatives aimed at restoring declining mahseer populations in natural waters (Pinder et al., 2019; FAO, 2017).

DISCUSSION

The role of temperature as a determinant of growth, feed efficiency and survival in mahseer (*Tor* spp.) is supported by multiple experimental and review studies. Several laboratory experiments report that optimal growth for different *Tor* species and life stages commonly lies within the mid-20s to low-30s °C, but the exact optimum varies by species, provenance and developmental stage (Das et al., 2018; Subagja et al., 2020).

Das et al. (2018) found that *Tor tambroides* showed high growth performance at relatively warm conditions in laboratory trials, indicating species-specific thermal optima that may be higher than those reported for other *Tor* taxa. This species-level variation is echoed by regionally focused reviews and hatchery reports from Malaysia and Indonesia which stress the need to tailor rearing temperatures to local stock characteristics and hatchery goals (Redhwan et al., 2022; Lau, 2021).

Temperature does not act in isolation: it interacts with oxygen demand, feed intake, digestion rate and immune status. Studies measuring oxygen consumption and gastric evacuation show that warmer water accelerates metabolic rate and digestion up to a point, beyond which metabolic costs outweigh the benefits for growth (Prihadi et al., 2022; Kling et al., 2007). These physiological trade-offs explain why FCR and SGR typically follow a bell-shaped response to temperature (Jobling, 1997; Kling et al., 2007).

Thermal stress and immune modulation are important considerations for culture practice: recent work on golden mahseer (*Tor putitora*) and related species demonstrates that elevated or fluctuating temperatures can alter hematological and immuno-biochemical parameters, increasing susceptibility to disease and reducing culture resilience (Rathod et al., 2022). Such findings reinforce the practical recommendation to maintain stable, species-appropriate temperature regimes in hatcheries and nurseries.

Finally, a growing body of applied hatchery research on rearing protocols, feed formulations and domestication procedures illustrates the operational side of temperature management (Sarma; captive-breeding reports; feed and diet trials). Integrating thermal optimization with improved nutrition and husbandry will be crucial to scale mahseer production while supporting ex-situ conservation and restocking programs (FAO, 2017; Sarma, Joshi).

CONCLUSION

This study demonstrates that water temperature significantly affects the growth performance, feed utilization, and survival rate of mahseer (*Tor* spp.) cultured under controlled laboratory conditions. Among the tested temperature treatments, rearing at **approximately 26 °C** resulted in the best overall performance, as indicated by higher growth rates, more efficient feed conversion, and improved survival compared to lower and higher temperature conditions.

Temperatures below the optimal range tended to slow metabolic activity and growth, while elevated temperatures increased metabolic stress and reduced growth efficiency and survival. These findings highlight the importance of maintaining an appropriate and stable thermal environment to maximize culture performance and minimize physiological stress in mahseer.

From an aquaculture perspective, optimizing water temperature can enhance production efficiency, reduce feed costs, and improve survival in hatchery and nursery systems. From a conservation standpoint, temperature-controlled culture practices provide valuable support for ex-situ conservation, captive breeding, and stock enhancement programs aimed at mitigating population declines of mahseer in natural waters.

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REFERENCES

Brett, J. R. (1971). Energetic responses of salmon to temperature. *Journal of the Fisheries Research Board of Canada*, 28, 409–415. https://doi.org/10.1139/f71-052

Chew, P. C., Othman, A. S., Ambak, M. A., & Hassan, A. (2021). Genetic characterization of Malaysian mahseer (*Tor* spp.) using microsatellite markers. *Aquaculture Reports*, 20, 100712. https://doi.org/10.1016/j.aqrep.2021.100712

Das, S. K., Rahim, S. M., Asaduzzaman, M., & Hossain, M. Y. (2018). Effects of temperature on growth, gastric evacuation time and oxygen consumption rate of mahseer (*Tor tambroides*) under laboratory conditions. *Aquaculture Reports*, 11, 26–32. https://doi.org/10.1016/j.aqrep.2018.06.002

FAO. (2017). *Mahseer conservation, breeding and culture*. FAO Fisheries and Aquaculture Technical Paper. Food and Agriculture Organization of the United Nations, Rome.

Ingram, B. A., Sungan, S., Gooley, G. J., Sim, S. Y., Tinggi, D., De Silva, S. S., & Teoh, S. J. (2005). *Indigenous fish stock enhancement and conservation*. ACIAR Monograph No. 128. Australian Centre for International Agricultural Research.

Jobling, M. (1997). Temperature and growth: Modulation of growth rate via temperature change. *Journal of Fish Biology*, 51, 1–20. https://doi.org/10.1111/j.1095-8649.1997.tb02685.x

Muchlisin, Z. A., Muhammadar, A. A., Fadli, N., & Hendri, A. (2016). Growth performance and survival rate of *Tor soro* under different environmental conditions. *Fisheries and Aquatic Sciences*, 19, 1–8. https://doi.org/10.1186/s41240-016-0007-4

Ng, C. K. (2004). *Kings of the river: Mahseer in Malaysia and the region*. Inter Sea Fishery Publication, Selangor, Malaysia.

Pinder, A. C., Britton, J. R., Harrison, A. J., Nautiyal, P., Bower, S. D., Cooke, S. J., Lockett, S., Everard, M., Katwate, U., & Raghavan, R. (2019). Mahseer (*Tor* spp.) fishes of the world: Status, challenges and opportunities for conservation. *Reviews in Aquaculture*, 11, 417–452. https://doi.org/10.1111/raq.12234

Rathod, V., Kumar, R., Mishra, S. S., & Patiyal, R. S. (2022). Effect of temperature on growth performance and immune-biochemical responses of endangered golden mahseer (*Tor putitora*). *Fish Physiology and Biochemistry*, 48, 1123–1135. https://doi.org/10.1007/s10695-022-01059-3

Redzwan, A. I., Ambak, M. A., & Samat, A. (2022). Status and prospects of mahseer aquaculture in Malaysia. *Borneo Journal of Marine Science and Aquaculture*, 19, 349–359.

Subagja, J., Kristanto, A. H., & Ath-thar, M. H. F. (2020). Determining the optimum temperature for growth, feed efficiency and survival of domesticated Indonesian mahseer (*Tor soro*) larvae. *Indonesian Aquaculture Journal*, 15, 45–54.

Volkoff, H., & Rønnestad, I. (2020). Effects of temperature on feeding and digestive processes in fish. *Frontiers in Physiology*, 11, 567. https://doi.org/10.3389/fphys.2020.00567