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Consequence of photoperiods on growth and development of guppy fish (*Poecilia reticulata*)

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Abstract
This study investigated the effects of different photoperiod regimes on the growth and development of juvenile guppy fish (*Poecilia reticulata*) under controlled laboratory conditions. The experiment was conducted at a research facility in South West Khasi Hills District, Meghalaya, India, over a 90-day period. Newly hatched guppy juveniles were randomly assigned to five experimental groups with different light exposure durations: 24 hours continuous light (24 h LED), 18 hours light (18 h LED), 12 hours light (12 h LED), 6 hours light (6 h LED), and 24 hours darkness (24 h dark). Each treatment was replicated in separate 20-liter aquaria with standardized feeding and water quality management protocols. Growth parameters including body weight, total length, specific growth rate (SGR), and survival rate were measured at 0, 45, and 90 days. Water quality parameters (temperature, pH, dissolved oxygen, and alkalinity) were monitored throughout the experimental period. Results showed that fish exposed to 18 hours of LED light (Setup B) exhibited the highest growth performance with weight gain of 0.35±0.0026 g, length gain of 18±0.53 mm, and 100% survival rate. Fish maintained under continuous darkness showed the poorest growth performance. These findings suggest that an 18-hour photoperiod provides optimal conditions for juvenile guppy growth and development, balancing metabolic stimulation with adequate recovery periods.

Keywords: Photoperiod, guppy fish, growth performance, photoperiod

1. Introduction

Light exposure plays a crucial role in regulating biological rhythms in aquatic organisms, influencing physiological processes including growth, metabolism, and reproductive development (Boeuf & Le Bail, 1999) [1]. In fish, photoperiod manipulation has been recognized as an effective tool for optimizing growth performance and synchronizing reproductive cycles in both commercial and ornamental aquaculture (Puvanendran & Brown, 2002) [7].

The guppy (*Poecilia reticulata*) is a popular ornamental fish species known for its adaptability, short generation time, and continuous reproductive cycle, making it an ideal model organism for photoperiod studies (Magurran, 2005) [4]. Previous research has demonstrated that environmental factors, including light regime, significantly influence growth rates and developmental patterns in small tropical fish species (Villamizar *et al.*, 2011) [9].

Understanding the optimal photoperiod requirements for guppy cultivation has practical implications for the ornamental fish industry, particularly in developing sustainable aquaculture practices (Meffe & Snelson, 1989; Ramanayake *et al.*, 2019) [5, 8]. The present study aims to determine the most effective photoperiod regime for maximizing growth performance and survival rates in juvenile guppies, with potential applications in commercial breeding operations.

2. Materials & Methods

2.1 Experimental Site and Setup

The experiment was conducted at the Backyard Ornamental Fish Farming facility, South West Khasi Hills District, Meghalaya, India. Five identical glass aquaria (38 cm × 23 cm × 30 cm) with a water capacity of 20 liters each were used for the experimental setup.

2.2 Fish Collection and Acclimatization
Newly hatched guppy juveniles (*P. reticulata*) were collected from breeding tanks at the research facility. Fish were acclimatized for 24 hours under ambient conditions before being randomly distributed among experimental tanks (20 individuals per tank).

2.3 Experimental Design
Five photoperiod treatments were applied using 10-watt LED lights:
- Setup A: 24 hours continuous light (24 h LED)
- Setup B: 18 hours light : 6 hours dark (18 h LED)
- Setup C: 12 hours light : 12 hours dark (12 h LED)
- Setup D: 6 hours light : 18 hours dark (6 h LED)
- Setup E: 24 hours continuous darkness (24 h dark)

Light intensity was maintained at approximately 1000 lux at the water surface. The experiment duration was 90 days.

2.4 Water Quality Management
Water quality parameters were monitored weekly and maintained within optimal ranges:
- Temperature: 26±1 °C
- pH: 7.0-8.0
- Dissolved oxygen: 6-8 mg/L
- Total alkalinity: 90-160 mg/L

Continuous aeration was provided for 8 hours daily in all tanks using air pumps. Water changes (25% of total volume) were performed weekly.

2.5 Feeding Protocol
Fish were fed three times daily (07:00-08:00, 12:00-13:00, and 16:00-17:00) with a combination of:
- Live feed (Infusoria)
- Freeze-dried tubifex worms
- Commercial pellets (appropriate size for juveniles)

Feed quantity was adjusted based on fish size and consumption rates to prevent overfeeding.

2.6 Growth Measurements
Growth parameters were recorded at three time points: initial (Day 0), intermediate (Day 45), and final (Day 90). Individual fish were measured for:
- Body weight (g) using a digital balance (±0.001 g accuracy)
- Total length (mm) using a measuring board (±0.1 mm accuracy)

2.7 Development Factors
Development factors such as growth parameters were calculated using the following formulas:

Weight Gain (WG): Final weight-Initial weight

Length Gain (LG): Final length-Initial length

Specific Growth Rate (SGR): $[(\ln W_f - \ln W_i)/D] \times 100$ Where: Wf = final weight, Wi = initial weight, D = duration in days

Survival Rate (%): (Final number of fish/Initial number of fish) × 100

Data are presented as mean ± standard error (SE). Statistical analysis was performed using appropriate tests to determine significant differences between treatments ($p < 0.05$).

3. Results
3.1 Water Quality Parameters
Water quality parameters remained within acceptable ranges throughout the experimental period across all treatments (Table 1). No significant differences were observed between treatments, indicating that photoperiod manipulation did not adversely affect water chemistry.

Table 1: Water quality parameters during the experimental period

Parameter	Setup A (24 h LED	Setup B (18 h LED)	Setup C (12 h LED)	Setup D (6 h LED)	Setup E (24 h DARK)
Temperature (°C)	26±0.5	26±0.5	26±0.5	26±0.5	26±0.5
pH	7.5±0.3	7.5±0.3	7.5±0.3	7.5±0.3	7.5±0.3
Dissolved oxygen (mg/L)	7.2±0.8	7.2±0.8	7.2±0.8	7.2±0.8	7.2±0.8
Alkalinity (mg/L)	125±25	125±25	125±25	125±25	125±25

3.2 Growth Performance-Weight
Weight measurements showed progressive increases across all treatments, with Setup B (18 h LED) demonstrating the highest growth rates (Table 2). Fish in this treatment achieved the greatest final weight (0.44±0.006 g) and total weight gain (0.35±0.0026 g) over the 90-day period.

Table 2: Weight performance of juvenile guppies under different photoperiod treatments

Treatment	Initial weight (g)	Day 45 Weight (g)	Final weight (g)	Weight Gain (g)
Setup A (24 h LED)	0.08±0.003	0.19±0.003	0.39±0.003	0.29±0.003
Setup B (18 h LED)	0.09±0.003	0.22±0.005	0.44±0.006	0.35±0.003
Setup C (12 h LED)	0.07±0.003	0.16±0.004	0.34±0.004	0.27±0.038
Setup D (6 h LED	0.07±0.003	0.14±0.003	0.30±0.003	0.23±0.004
Setup E (24 h dark)	0.06±0.003	0.11±0.003	0.23±0.003	0.17±0.003

3.3 Growth Performance-Length
Length measurements followed similar patterns to weight data, with Setup B showing superior performance (Table 3). The 18-hour photoperiod treatment resulted in the highest final length (30±0.46 mm) and length gain (18±0.53 mm).

Table 3: Length performance of juvenile guppies under different photoperiod treatments

Treatment	Initial Length(mm)	Day 45 Length (mm)	Final Length (mm)	Length Gain (mm)
Setup A (24 h LED)	9±0.17	17±0.15	25±0.32	16±0.32
Setup B (18 h LED)	9±0.15	18±0.17	30±0.46	18±0.53
Setup C (12 h LED)	9±0.17	15±0.28	24±0.32	15±0.46
Setup D (6 h LED	8±0.17	13±0.18	17±0.33	9±0.20
Setup E (24 h dark)	8±0.20	11±0.18	14±0.32	6±0.19

3.4 Overall Growth Performance and Survival:
Table 4 summarizes the overall growth performance parameters. Setup B (18 h LED) achieved the highest specific growth rate (1.763) and perfect survival rate (100%), while Setup E (24 h dark) showed the poorest performance across all parameters.

Table 4: Overall growth parameters and survival rates

Treatment	Length Gain (mm)	Weight Gain (g)	Specific Growth Rate	Survival Rate
Setup A (24 h LED)	16±0.32	0.29±0.003	1.760	95
Setup B (18 h LED)	18±0.53	0.35±0.003	1.763	100
Setup C (12 h LED)	15±0.46	0.27±0.038	1.756	90
Setup D (6 h LED	9±0.20	0.23±0.004	1.616	95
Setup E (24 h dark)	6±0.19	0.17±0.003	1.611	85

4. Discussion
The results of this study clearly demonstrate that juvenile guppies (*P. reticulata*) exhibit differential growth responses when subjected to varying photoperiod regimes. Biswas *et al.*, (2006) [2] also express that photoperiod can manipulate the growth juvenile red sea bream. The most significant finding is that fish maintained under an 18-hour light photoperiod (Setup B) achieved superior growth performance compared to all other treatments, with the highest weight gain, length gain, specific growth rate, and survival rate.

These findings align with previous research on photoperiod effects in fish. Boeuf and Le Bail (1999) [1] demonstrated that moderate light exposure periods can optimize metabolic processes in small fish species. The superior performance of the 18-hour photoperiod treatment suggests an optimal balance between metabolic stimulation during light periods and physiological recovery during dark periods.

The poor performance observed under continuous darkness (Setup E) supports the importance of light as a feeding stimulus and metabolic regulator. Fish maintained in complete darkness showed reduced feeding activity and growth, likely due to impaired visual feeding behavior and disrupted circadian rhythms (Migaud *et al.*, 2010) [6].

Interestingly, continuous light exposure (Setup A) did not produce the best results, despite providing maximum feeding opportunities. This suggests that fish require periods of darkness for optimal physiological function, possibly for hormonal regulation including melatonin production, which plays a crucial role in growth and stress response (López-Olmeda & Sánchez-Vázquez, 2011) [3].

The intermediate photoperiods (12 h and 6 h LED) showed growth performance that corresponded to their light exposure duration, with longer photoperiods generally producing better results. This dose-response relationship supports the hypothesis that light exposure duration directly influences growth capacity within certain limits.

From a practical aquaculture perspective, these results suggest that implementing an 18-hour photoperiod could significantly improve production efficiency in ornamental guppy farming. The combination of enhanced growth rates and perfect survival rates makes this photoperiod regime economically attractive for commercial operations.

5. Conclusion
This study demonstrates that photoperiod manipulation significantly affects growth performance in juvenile guppies. An 18-hour light photoperiod proved optimal for maximizing weight gain, length gain, and survival rates while maintaining efficient growth rates. The findings suggest that moderate photoperiod regimes that balance metabolic stimulation with adequate recovery periods are most effective for juvenile guppy culture.

These results have practical implications for ornamental fish aquaculture, providing evidence-based recommendations for optimizing production systems. Future research should investigate the long-term effects of photoperiod manipulation on reproductive performance and the economic feasibility of implementing controlled lighting systems in commercial operations.

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