



Research Paper

Comparative Effects of Live Feed and Formulated Feed on Growth Performance and Survival of *Gambusia affinis* Larvae

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Received: 02/09/2026

Revised: 10/09/2026

Accepted: 18/09/2026

Abstract: The present study evaluated the effects of live and formulated feeds on growth, survival and condition factor of *Gambusia affinis* larvae under controlled laboratory conditions. Forty-six larvae collected from Mohan Ram Pond, Shahdol, Madhya Pradesh, were randomly allocated to two experimental tanks (23 larvae per tank) and reared for 84 days. The live-feed treatment received *Artemia nauplii*, Daphnia and mosquito larvae, whereas the formulated-feed treatment received commercially available Taiyo aquarium fish feed. Fish were fed once daily. Body length and body weight were recorded at regular intervals, while survival and Fulton's condition factor (K) were calculated. Temperature, pH, total hardness and total ammonia were monitored weekly. Larvae receiving live feed attained a final mean length of 4.70 cm and body weight of 1.2564 g, compared with 4.00 cm and 0.7682 g, respectively, under formulated feeding. Length gain was 4.20 cm with live

feed and 3.60 cm with formulated feed, while weight gain was 1.2550 and 0.7675 g, respectively. Final survival was 65.22% in the live-feed treatment and 56.52% in the formulated-feed treatment. Fulton's K remained above 1.0 in both treatments (1.12–1.21 and 1.07–1.20, respectively). Water quality remained within the observed ranges of 25–36 °C, pH 5.6–7.6, hardness 280–450 mg L⁻¹ and ammonia 0.3–0.5 mg L⁻¹. The findings indicate that both diets supported larval development, but the live-feed regime was associated with greater growth and survival under the conditions of this trial. The study provides baseline information for improving larval feeding practices for *G. affinis* in laboratory and small-scale hatchery systems.

Keywords: *Gambusia affinis*; live feed; formulated feed; *Artemia*; Daphnia; mosquito larvae; larval rearing; growth; survival; condition factor

Introduction:

Aquaculture and ornamental fish culture depend strongly on successful larval rearing, during which feed quality, feeding behaviour and environmental conditions can determine subsequent growth and survival. Fish larvae generally have high metabolic demands and developing digestive systems, making the availability of appropriately sized, palatable and digestible food particularly important (Halver & Hardy, 2002; NRC, 2011).

Gambusia affinis, commonly known as the mosquito fish, is a small live-bearing freshwater fish of the family Poeciliidae. It is widely recognized for consuming mosquito larvae and has been introduced into numerous regions for biological mosquito control. Its adaptability, rapid reproduction, small size and tolerance of variable environmental conditions also make it useful in laboratory and educational studies (Pyke, 2005, 2008).

Live feeds such as *Artemia*, *Daphnia*, *Moina* and mosquito larvae are widely used in fish larval rearing because they provide readily ingestible food and can stimulate natural feeding behaviour. Their movement in the water column can increase encounter rates with visual-feeding larvae, while their nutritional composition may provide proteins, lipids, vitamins and other nutrients required during early development (Lavens & Sorgeloos, 1996; Sorgeloos et al., 2001).

Formulated feeds provide practical advantages including ease of storage, consistent composition, transportability and year-round availability. However, inert particles may be less readily accepted by very small larvae, and feed loss or leaching may occur if particle size and feeding practices are not appropriate (De Silva & Anderson, 1995; Halver & Hardy,

2002). Water quality is another important component of larval culture because temperature, pH, hardness and ammonia influence physiological processes, feed utilization and survival (Boyd & Tucker, 1998; APHA, 2023).

Although *Gambusia* is frequently maintained for mosquito-control purposes, comparative information on larval performance under different feeding regimes remains limited in local laboratory conditions. Therefore, the present study compared live feed and a commercial formulated feed for growth, survival and condition factor of *G. affinis* larvae over a 12-week period, while monitoring selected water-quality variables.

Materials and Methods:

Study site and experimental period

The experiment was conducted in the Fisheries Laboratory, Department of Fisheries Science, Pandit Shambhu Nath Shukla University, Shahdol, Madhya Pradesh, India. The study was carried out from April to June 2026 for 84 days (12 weeks). *Gambusia affinis* larvae were collected from Mohan Ram Pond, Shahdol, transported to the laboratory and acclimatized before experimental observations.

Experimental design

Forty-six larvae were randomly divided between two plastic experimental tanks, with 23 larvae in each tank. Each tank contained approximately 14 L of dechlorinated freshwater, giving an approximate stocking density of 1.64 fish L⁻¹. Tanks were cleaned before stocking and aquatic plants including *Hydrilla* and *Ceratophyllum* were maintained to support the culture environment. Feeding was carried out once daily.

Treatment	Diet	Larvae	Duration
T1	Live feed: Artemia nauplii, Daphnia and mosquito larvae	23	84 days
T2	Formulated feed: Taiyo aquarium fish feed	23	84 days

Feed treatments

The live-feed treatment consisted of Artemia nauplii, Daphnia and mosquito larvae. The thesis records approximate crude-protein values of 50–60% for Moina, 45–55% for Daphnia and 40–60% for mosquito larvae. The formulated diet was commercially available Taiyo aquarium fish feed, finely powdered for larval consumption; the recorded proximate composition was 28% crude protein, 3% crude fat, 4% carbohydrate and 10% moisture.

Growth and survival measurements

Body length was measured in centimetres using a thread and graduated scale, and body weight was measured in grams using a digital electronic balance. Observations were recorded at weekly intervals. Length gain was calculated as final average length minus initial average length, and weight gain as final average weight

minus initial average weight. Survival was calculated as: $\text{Survival (\%)} = (\text{number of fish survived} / \text{number initially stocked}) \times 100$.

Fulton's condition factor was calculated as $K = (W \times 100) / L^3$, where W is body weight in grams and L is body length in centimetres. The study compared observed growth, survival and K values between the two experimental treatments.

Water-quality monitoring

Temperature, pH, total hardness and total ammonia were monitored weekly. Temperature was measured with a laboratory thermometer; pH and ammonia were assessed with commercial testing kits; and total hardness was determined by the EDTA titration method and expressed as mg L^{-1} as CaCO_3 . Tanks were cleaned and water replaced when required.

Results:

Growth performance

Parameter	Fish fed with Live feed (T1)	Fish fed with Formulated feed (T2)
Initial average length (cm)	0.50	0.40
Final average length (cm)	4.70	4.00
Length gain (cm)	4.20	3.60
Initial average weight (g)	0.0014	0.0007
Final average weight (g)	1.2564	0.7682
Weight gain (g)	1.2550	0.7675
Final K range	1.12–1.21	1.07–1.20
Final survival (%)	65.22	56.52

Both treatments showed progressive growth during the experimental period. At the end of

Week 12, larvae in the live-feed tank reached 4.70 cm and 1.2564 g, whereas those receiving

formulated feed reached 4.00 cm and 0.7682 g. Thus, the live-feed treatment produced 0.70 cm greater final mean length and 0.4882 g greater

final mean body weight than the formulated-feed treatment.

Observation point	Fish fed with Live feed: length (cm)	Fish fed with Live feed: weight (g)	Fish fed with Formulated feed : length (cm)	Fish fed with Formulated feed: weight (g)
Week 1, Day 2	0.5	0.0014	0.4	0.0007
Week 3, Day 5	1.7	0.0565	1.4	0.0313
Week 6, Day 5	3.0	0.3195	2.7	0.2317
Week 9, Day 5	4.0	0.7682	3.3	0.4273
Week 12, Day 5	4.7	1.2564	4.0	0.7682

Condition factor

Fulton's condition factor remained above 1.0 in both treatments. In the live-feed group, K increased from 1.12 at the beginning of the

recorded observation sequence to 1.21 at the end. In the formulated-feed group, K increased from 1.07 to 1.20. These observations indicate that both feeding regimes supported continued body development during the trial.

3.3 Survival

Metric	Live feed (T1)	Formulated feed (T2)
Initial population	23	23
Week 1 survival	82.61%	69.57%
Final population	15	13
Final cumulative survival	65.22%	56.52%
Difference in final survival	8.70 percentage points	—

Mortality was concentrated in the early part of the experiment. In the live-feed treatment, four larvae died during Week 1, three during Week 4 and one during Week 6; no additional mortality was recorded from Week 7 through

Week 12. In the formulated-feed treatment, seven larvae died during Week 1 and three during Week 7; no additional mortality was recorded from Week 8 through Week 12.

Water quality:

Parameter	Observed range
Temperature	25–36 °C
pH	5.6–7.6
Total hardness	280–450 mg L ⁻¹ as CaCO ₃
Total ammonia	0.3–0.5 mg L ⁻¹

The weekly records showed closely similar environmental conditions between the two tanks. Temperature ranged from 25 to 36 °C, pH from 5.6 to 7.6, hardness from 280 to 450 mg L⁻¹ and ammonia from 0.3 to 0.5 mg L⁻¹. Therefore, large differences in measured water-quality conditions were not evident between treatments during the study.

Discussion:

The present experiment showed higher final length, weight gain and cumulative survival in *G. affinis* larvae receiving the live-feed regime. Live-fed larvae attained 4.70 cm and 1.2564 g, compared with 4.00 cm and 0.7682 g under formulated feeding. The pattern is consistent with the established importance of highly digestible and palatable food during early fish development (Halver & Hardy, 2002; Lavens & Sorgeloos, 1996).

The movement of live prey may be particularly relevant to a visually oriented larval predator. Artemia, Daphnia and mosquito larvae remain detectable in the water column and can stimulate feeding behaviour. In contrast, powdered inert feed does not provide the same visual and behavioural stimulus and may settle or disperse before being consumed. (Dabrowski, 1984; Cahu & Zambonino Infante, 2001).

The study also recorded an increase in body weight in the live-feed group after Week 6, when mosquito larvae became the principal live food in the recorded feeding sequence. Survival followed a similar pattern. Final cumulative survival was 65.22% in the live-feed group and 56.52% in the formulated-feed group. The greatest mortality occurred during the first week in both treatments, suggesting that the

early feeding period was particularly sensitive. The difference in Week 1 survival was 13.04 percentage points. Later in the trial, surviving larvae showed substantially greater stability, with 100% weekly survival recorded during the later weeks in both treatments.

Fulton's K remained above 1.0 in both treatments, indicating that formulated feed was also capable of supporting continued development and body condition under the experimental conditions. The higher absolute growth observed with live feed should therefore be interpreted alongside the fact that both diets supported surviving larvae.

Water quality was broadly comparable between treatments, with ammonia remaining at 0.3–0.5 mg L⁻¹ and pH ranging from 5.6 to 7.6. Because both groups experienced similar measured environmental conditions, the observed difference in growth is compatible with a dietary contribution.

Conclusion:

Under the conditions of the 84-day laboratory trial, both live and formulated feeds supported growth and development of *Gambusia affinis* larvae. The live-feed regime produced greater final length (4.70 cm), final weight (1.2564 g), length gain (4.20 cm), weight gain (1.2550 g) and final cumulative survival (65.22%) than the formulated-feed regime (4.00 cm, 0.7682 g, 3.60 cm, 0.7675 g and 56.52%, respectively). Condition factor remained above 1.0 in both groups. These findings support the use of live food as an effective larval feeding option for *G. affinis* under the experimental conditions, while also demonstrating that formulated feed can sustain continued development.

Acknowledgements:

The authors acknowledge the Department of Fisheries Science, Pandit Shambhu Nath Shukla University, Shahdol, Madhya Pradesh, for providing laboratory facilities and support. The authors also acknowledge the guidance and assistance provided during the experimental work.

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