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Original Article

Effect of mixed and artificial feeding on the growth performance of Gattan, *Luciobarbus xanthopterus* Heckel, 1843 larvae

Nawras A. Al-Faiz*[1], Ghassan A. Al-Najar[1], Faleh M. Al-Zaidy[2], Kadhim H. Younis[2], Amir A. Jabir[2]

[1]College of Marine Sciences, University of Basrah, Basrah, Iraq.
[2]Marine Science Center, University of Basrah, Basrah, Iraq.

Abstract: This work aimed to study the rearing feasibility of *Luciobarbus xanthopterus* larvae using artificial and mixed (live (*Chlorella* sp.) + artificial) food and their effects on their growth performance during early development. Larvae (1.65 cm in length and 0.02 g weight) were obtained from a Marine Science Hatchery and cultured in indoor tanks for 35 days. The larvae fed mixed feed T1 and artificial feed T2 (fish meal + soybean meal). The results showed that the larvae of T1 treatment outperformed significantly in final length, final weight, final weight gain, daily and specific growth rate, which amounted to 3.44 cm, 0.3568 g, 0.3368 g, 0.0096 g/day, and 8.2185 % weight/day, respectively. Also, the results showed that larvae fed on T1 grew faster. The present study showed that applying a mixture of artificial and live food after four weeks' age i.e. after absorption of the yolk sac for feeding larvae can reduce the costs of producing and providing better growth and survival rates.

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Introduction

Food security is a serious issue because of the rapid population increase. Aquaculture is the fastest-growing sector in animal protein production (Garcia et al., 2005; Daniel, 2018). It is one of the world's most important high-quality protein sources (FAO, 2020; Stankus, 2021). The larvae rearing stage is the most challenging practice in the aquaculture industry. Fish larvae are cultured under highly controlled circumstances, particularly regarding feeding strategies (Lavens and Sorgeloos, 1996). Cyprinids are of great economic importance taxa since it includes the most important farmed fishes globally (FAO, 2014). Gattan, *Luciobarbus xanthopterus* is an important species in the inland waters of Iraq. It has high economic value and is a favorite fish among Iraqi consumers. In the Iraqi part of the Tigris and Euphrates River system, it is prevalent, especially in the central and southern regions (Al-Rudainy, 2002).

Introducing alien fish species, and overfishing have declined the native fishes, such as Gattan, and even this species has disappeared in some regions (Al-Najare, 2020). The production of freshwater fishes in Iraq consists of the common carp, grass, and silver carp, and there are no sufficient attempts to develop those native fish candidates to rear due to the limitation of supplying the quality larvae (FAO, 2011). According to Bawazeer (1981) in Lake Habbaniyah, and Polservice Consulting Engineers (1983) in Lake Tharthar, Gattan did not attract the interest of fish farmers, because of its slow-growing in natural waters (Al-Rudainy et al., 1997). Later studies showed that Gattan is suitable for the culture as commercial production in ponds (Almukhtar et al., 2009) based on the results of its growth performance indicators, nutrition, and environmental factors tolerance (Al-Mahdawi et al., 1996; Al-Rudainy et al., 1997; Al-Azawi et al., 1999; Al-Rudainy et al., 2002; Al-Rudainy et al., 2004).

Larvae rearing is one of the most crucial phases in fish farming. This stage is the most challenging stage in the life history of fishes since the mortality is high

*Correspondence: Nawras A. Al-Faiz
E-mail: nawras.abdulzahra@uobasrah.edu.iq
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Table 1. Measurements of some environmental factors of the rearing tanks (Data expressed as Mean±SD).

Environmental variables	Time				
	7 days	14 days	21 days	28 days	35 days
Temperature ˚C	25.62±0.16	25.77±0.23	26.48±0.15	26.88±0.12	27.32 ±0.35
dissolved oxygen (mg/l)	6.85±0.11	6.84±0.13	6.96±0.17	6.87±0.11	6.90±0.08
Salinity ‰	1.70±0.22	2.09±0.08	2.55±0.38	2.50±0.35	2.47±0.40
pH	7.51±0.08	7.54±0.17	7.46±0.11	7.47±0.12	7.55±0.19

during this stage. This study aimed to investigate the rearing feasibility of Gattan larvae in indoor systems using artificial and mixed (live + artificial) food and their effects on their growth performance during early development.

Materials and methods

Gattan larvae were obtained from the fish hatchery of the Marine Sciences Center, University of Basrah, and transferred to the Marine Sciences Center's Aquaculture Laboratory using three-liter plastic containers equipped with aerators. The larvae were acclimated to the laboratory conditions using live food for 14 days. The experiments were performed in 200 L fiberglass tanks equipped to aerators. After the acclimatization period, the larvae were distributed into the rearing tanks (200 L) at 50 larvae/tank (larvae had an average weight of 0.020 g, and an average total length of 1.65 cm) i.e. a density of 1 larva/4 liter. Throughout the 35-day experiment period, the larvae were fed to satiation using two food treatments, including T1 (a mixture of fish meal, soybean meal, and algae (*Chlorella* sp.)) and T2 (artificial food consisting of fish meal and soybean meal) as twice a day. Larvae' total length and weight were measured weekly using a ruler and sensitive balance (type METTLER model AE163), respectively. Some of the physical and chemical environmental factors, including temperature, dissolved oxygen, pH, and salinity, were monitored during the rearing period using a German-made Livebond water quality meter. The larvae's growth performance was evaluated using weight gain, daily growth rate (DGR), and specific growth rate (SGR) based on the following formulas:

Weight Gain (g) = Final weight - Initial weight

DGR (g / day) = Final weight - Initial weight / time (days)

SGR (% weight / day) = 100 × (Ln Final weight – Ln Initial weight) / time (days)

Statistical analysis: The data was analyzed using SPSS version 22.0. One-way analysis of variance (One-way ANOVA) was used to compare the treatments. The significant difference between means was examined by the least significant difference test (LSD test). All the differences were considered significant at $P<0.05$.

Results

During the rearing period, the temperature was 25.62-27.32℃, dissolved oxygen 6.84-6.96 mg /L, salinity 1.70-2.55‰ and pH 7.46-7.55 (Table 1). The total length, final weight, and weight gain rates, and the daily and specific growth rates of larvae fed T1 and T2 treatment are shown in Table 2.

The results showed a significant increase in the mean total length of T1 (3.440 cm) compared to T2 (3.18 cm) ($P<0.05$). The highest final weight and weight gain were found in larvae of T1 (0.3568 and 0.3368 g, respectively), with a significant difference ($P<0.05$) compared to T2 (0.2796 and 0.2596 g, respectively). The highest daily growth rate (DGR) was 0.0096 g/day, and the highest specific growth rate (SGR) was 8.2185% weight/day in the larvae of T1. In T2, they were 0.0074 g/day and 7.5281% weight/day, respectively, having significant differences ($P<0.05$) between the treatments. Figure 1 shows weekly changes in mean length, mean weight, (mean weight gain, DGR, and SGR of *L. xanthopterus* larvae during five weeks rearing period. The larvae's mean total length, weight, and weight gain were increased during five weeks of the rearing period. The highest values of daily and specific growth rates during the experiment period were recorded in larvae of T1.

Table 2. The growth performance parameters of *Luciobarbus xanthopterus* larvae fed experimental diets after 5 weeks (Data expressed as Mean± SD).

Parameters	Diets	
	T1	T2
Initial length (cm)	1.65±0.01[a]	1.65±0.01[a]
Initial Weight (g)	0.020±0.002[a]	0.020±0.002[a]
Final length (cm)	3.4400±0.1140[a]	3.1800±0.1483[b]
Final Weight (g)	0.3568±0.0407[a]	0.2796±0.0232[b]
Weight Gain (g)	0.3368±0.0407[a]	0.2596±0.0232[b]
DGR (g / day)	0.0096±0.0012[a]	0.0074±0.0007[b]
SGR (% weight / day)	8.2185±0.321[a]	7.5281±0.2389[b]

The means in the same row with different letters mean show significant differences ($P<0.05$).

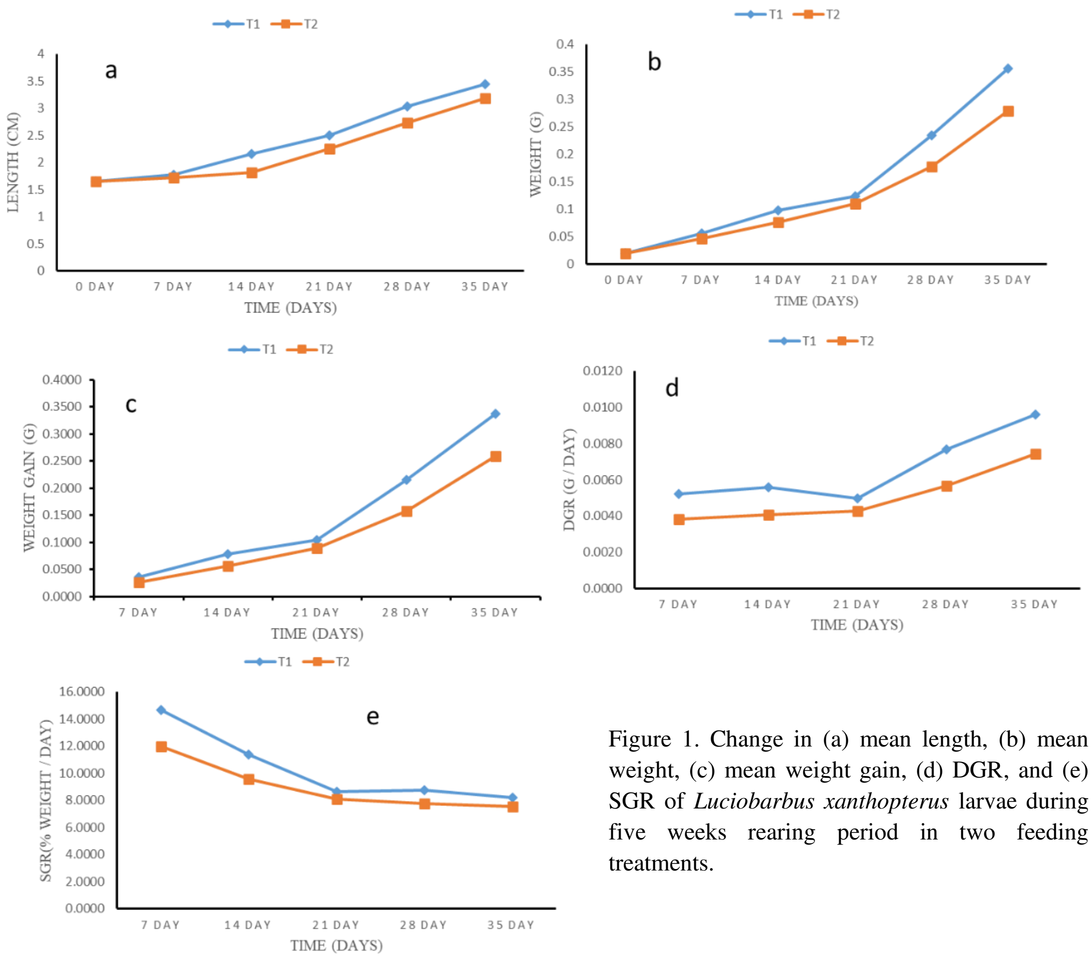

Figure 1. Change in (a) mean length, (b) mean weight, (c) mean weight gain, (d) DGR, and (e) SGR of *Luciobarbus xanthopterus* larvae during five weeks rearing period in two feeding treatments.

Discussion

The environmental factors in the present study showed that temperature, dissolved oxygen, salinity, and pH values were within the suitable ranges for rearing Gattan larvae (Ghazi, 2009; Yesser et al., 2016). It is crucial to determine the nutritional requirements of fish larvae to enhance their growth performance and survival rates (Radhakrishnan et al., 2020). Live food is the best food for fish cultivation since it has essential fish nutrition (Bengtson, 2003). Studies have indicated the importance of using protein sources having essential amino acids, phospholipids, and fatty acids in feeding aquatic organisms (Daniel, 2018). When live food suffers from a lack of essential nutrient components, it cannot be adopted as a single diet for larvae to enhance their growth performance, therefore, it needs to use mixing food (Radhakrishnan et al., 2020). Prolonged use of live food for rearing fish larvae is often impractical and expensive, and it is necessary a transformation to an artificial diet (Akbari et al., 2010). To ensure the sustainability of aquaculture operations, it is crucial to search for feed sources containing similar levels of all nutrients that live food provides to meet the nutritional needs of the larvae and replace the live food and rely on it to improve growth and survival rates (Salama, 2000; Daniel, 2018). Some studies have indicated the importance of algae as a source of protein in the feeding of fish as *Chlorella* algae are one of the rich protein sources. The content of some dried *Chlorella* algae had a crude protein of 50% compared to a fish meal whose protein level was 60% and soybean meal containing 44% protein (Lubitz, 1963; Campanella et al., 1999).

The results showed that T1 feed improved all growth performance indicators compared to T2. A mixture of live and artificial feed for fish may provide the required nutritional components for larvae. This indicates the possibility of using a mixture of live and artificial feed for improving the growth of larvae after the fourth week i.e. after yolk sac absorption. It is necessary to provide protein-rich foods for fish larvae to enhance their growth and survival (Mandal et al., 2009). Phang (1992) pointed out the possibility of using algae as alternatives to animal protein sources due to its high production rates and nutritional value. Venkataraman and Becker (1985) showed the algae's nutritional value is estimated by its quantitative and qualitative content of amino acids.

The results of this study agree with the findings of Ghazi (2009), which indicated a decrease in growth rates and weight gain of larvae of Gattan fed live foods after four weeks of hatching and recommended the necessity of providing artificial foods along with live diets for larvae to improve their growth rates. Akbari et al. (2010) also showed a decrease in growth rates and weight gain of rainbow trout larvae fed on live foods compared to those given artificial diets or mixed diets (artificial and live foods) after four weeks. This study showed an increase in growth rates and weight gain compared to the results of previous studies (Ghazi, 2009; Yesser et al., 2016).

In conclusion, the present study showed that applying a mixture of artificial and live food after four weeks' age from absorption of the yolk sac for feeding by Gattan larvae can reduce the costs of producing and providing better growth and survival rates.

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