GROWTH PERFORMANCE OF *NOTOPTERUS NOTOPTERUS* (PALLAS 1769) LARVAE USING IN THREE DIFFERENT DIETS

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Abstract

The present work was investigated the growth performance of post-larvae *Notopterus notopterus* by using three different diets. A total of 300 post larvae, ranging from 2.9 cm to 3.4 cm in length and weighing between 0.02 g and 0.05 g, were divided into three groups and fed with three different live feeds: Moina, Tubifex, and Rotifer. The experiment were conducted for three triplicate. The fishes accepted all types of diets. The specific growth rate (SGR) was higher in post larvae fed on Moina (6.98±0.10%), followed by Tubifex (6.92±0.04%), with the lowest SGR was recorded for Rotifer (6.74±0.44%). The highest final mean weight and weight gain were observed in post larvae fed on Moina (2.64±0.16) g, followed by Tubifex (2.54±0.06) g, with the lowest weight gain recorded for Rotifer (2.30±0.31) g. No significant difference was observed in fish fed on Tubifex and rotifer, whereas Moina-fed larvae showed a significant difference ($p < 0.05$) compared to other two groups. The survival rate on day 60 was 83% for larvae fed on Moina and 82% for those fed on Rotifer, whereas the lowest survival rate of 75% was recorded for Tubifex-fed larvae. Therefore, The larvae of *Notopterus notopterus* could be reared using different livefood to promote enhanced growth and survival rate.

Keyword : *Notopterus notopterus*; Larval rearing; Different diets; SGR; Growth and Survival

Introduction

In Myanmar, *Notopterus notopterus (locally known as Nga-pe)* is one of the famous foods for the local people and one of the most economically important freshwater fish found in Myanmar. The meat of the featherback fish is tasty and has the highest nutrient value, resulting in a high price. A biochemical study conducted on the featherback knife fish revealed that it is a rich source of protein, with a protein content of 19.8% and a lipid content of about 5.0% (Kamal *et al.*, 2007).

In recent years, aquaculture has been recognized as an important strategy for meeting the growing demands of fish protein worldwide. Larval rearing is still consider the most critical aspect, and the development of rearing technology is essential for the conservation of fish species. The successes of larval rearing depend mainly on the availability of suitable diets that were readily consumed, efficiently digested, and provide the required nutrients to support higher growth and health (Sarkar *et al*., 2006).

Diet plays a significant role in aquaculture production. Different commercial feeds, such as nursery and grow out feed of various sizes, are available in the market. However, these feeds were manufactured based on the nutrient requirements of fry or young fish and may not fulfill the requirements of fish larvae. Fish larvae cannot feed on artificial supplemented feed; they require small live foods for their nutrition. Live foods are easily digestible, protein-rich diets for fish larvae. Live zooplankton, such as cladocerans (Moina and Daphnia), brine shrimps (Artemia), tubificids (Tubifex) and Rotifer are the most widely accepted live feeds globally and play a significant role in the feeding of cultivable species of fishes and crustaceans (Morris and Mischke, 1999). They are excellent first foods for larvae due to their relatively smaller size, slow swimming speed, the habit of staying suspended in the water column, and their ability to propagate in captivity at high density and reproductive rate. The availability of a suitable larval rearing diet is important for the propagation of many aquatic species because it plays a vital role in the growth, survival, and disease resistance during early stages (Sontakke *et al*., 2019). The success of larval rearing depend mainly on the availability of optimal diets that can be easily

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consumed, efficiently digested, and provided the required nutrients to support good growth, survival, and health (Giri *et al*., 2002).

Live feeds are considered a convenient and essential food source for the post larvae and fry of some cultivable fish species and are widely accepted as living capsules of nutrition. The use of an optimal live feed species is a vital role in survival and growth performance during early life stages. The aim of the present study was conducted to evaluate the growth performance and survival rates of *Notopterus notopterus* post larvae when fed three different diets. These diets are selected based on their high nutritional value, capacity to support growth in dense populations, and ease of mass production under controlled conditions.

Materials and Methods

Study Area and Study Period

The experiment was conducted at wet laboratory, Department of Zoology, Fisheries and Aquaculture, University of Yangon. Study period was lasted from November 2022 to January 2023.

Samples Collection

A total of 300 *Notopterus notopterus* post larvae were collected from Hlawga Fisheries Experimental Station to conduct the larvae diets experiment. The initial length of post larvae of *Notopterus notopterus was* 2.98±0.43 cm and their body weight was 0.03±0.01 g (Plate 1.). They were carried to the Aquatic Bioscience Laboratory, Fisheries and Aquaculture, Department of Zoology, University of Yangon for the experiment. They were divided into three groups and kept in (90cm×30cm×45cm) glass tanks through continuous aeriation for the experiment.

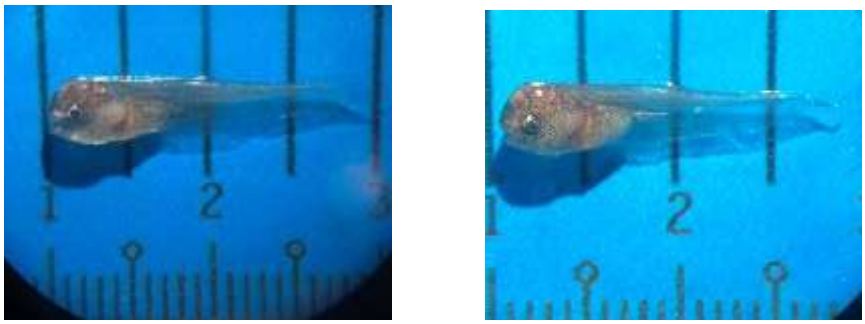

Plate. 1 Post larvae of *Notopterus notopterus* collected from Hlawga

Preparation of Diets

Three larval diets, Moina (*Moina* sp) , Rotifer (*Brachionus* sp) and Tubifex (*Tubifer* sp) were prepared. The initial seeds of Moina and Rotifer were received from the Aquatic Live Feed Laboratory, Department of Fisheries (DoF), Thaketa Township, Yangon region, while Tubifex was purchased from the local aquarium shop (Plate 2.). Mass culture of Moina and Rotifer was conducted in Live food Laboratory, Fisheries and Aquaculture, Department of Zoology, University of Yangon.

Plate 2. Preparation of diets for the post larvae of *Notopterus notopterus*

Culture of Moina

The five individuals of Moina were introduced to 1L of beaker filled with tap water. Moina was fed with 1 gram of baker's yeast during the culture period and maintained in the beaker with continuous aeration. The population of Moina in the beaker was checked every day by collecting the sub-sample 1ml of water. When the Moina population reached approximately 100-110 individuals per milliliter, they were transferred into fiber tanks with dimensions of 120cm x 120cm x 45cm for the mass production. Three fiber tanks were prepared for the mass production and Moina were treated with baker's yeast in the same ratio as described in above (1L/g). The fiber tanks was filled with 800L of tap water.

Culture of Rotifer

In order to obtain sufficient Rotifer density for the experiment five Rotifers were inoculated in three 500 mL beakers with tap water, with aeration and light availability. The Rotifers were fed daily with a mixture of algal diets (*Chlorella* sp.) at a concentration of approximately 40×103 cells/ ml. A total of 100ml of *Chlorella* sp. were added beakers of Rotifer and the density of Rotifer was checked as described in Moina everyday. When the sufficient density of adult Rotifer (10 individual/ml) was reached from the inoculated beakers, they were transferred into the 14 liters cylindrical plastic tanks for the mass culture. Rotifer were fed with 1000ml of *Chlorella* sp. per day (at $4.5x10^6$ cells ml^{-1}). The 40% of water was replaced every 5-6 days.

Preparation of Tubifex

Tubifex worms were sourced from the local aquarium shop and maintained in a 3-liter stainless steel bowl under a continuous running water system to remove dirt and debris. The worms were thoroughly rinsed before being fed to the fish larvae. They were sliced into small pieces to match the size of the fish's mouth.

Feeding Design

The larvae were feed twice a day, during the morning and evening at 09:00 am and 5:00 pm. The post larvae were treated with 5 g of three different diets. Five grams of Rotifers were equal to approximately 58,330 individuals, while Moina consisted of 12,695 individuals. The feeding trial was conducted for a period of 60 days. The fecal matters were removed by siphoning out and 80% of the water from each tank was changed everyday.

Water Quality Parameters

The water quality parameters were checked once every three days. Oxygen and temperature were measured using a DO Meter ID-150, and pH was measured using a pH meter Model TPX-999. 26.

Determination of Growth Parameters

The body weight and length of the fish were assessed at an interval of 15 days by randomly collecting 10 fish from each tank randomly. Fishes were starved overnight before being weighed on an electric balance to reduce their stress. The growth parameters such as percentage weight gain (%), specific growth rate (SGR) and survival rate (%) were calculated by using the following equations. (Cerozi and Fitzsimmons, 2017).

$$\text{Weight Gain (WG,g) \%} = \frac{Wf - Wi}{\text{Number of fish per tank}} \times 100$$

$$\text{Specific Growth Rate (SGR) \%} = \frac{Ln Wf - Ln Wi}{\text{Day of rearing period}} \times 100 \times 100$$

Where, Wf= Final weight of larvae
Wi= Initial weight of larvae

$$\text{Survival rate} = \frac{\text{Initial number of}}{\text{Final number of fish}} \times 100$$

Results

Growth Performance of Fingerling

In the present study, larval of *Notopterus notopterus* was treated using three different diets, and their growth and survival rates were calculated. During the experimental period, *Notopterus notopterus* exhibited a typical preying habit of swallowing feed with upward and downward movements, as well as good swimming behavior. No attacking behavior was observed.

The mean body length reached 4.84±0.45 cm in group I (Moina) while it was 5.03±0.10cm and 4.75±0.16 cm in group II (Tubifex) and group III (Rotifer), respectively. The final body length were 7.39±0.25cm 6.79±0.41cm and 6.76±0.34cm in group I (Moina), group II (Tubifex), and group III (Rotifer), respectively (Fig. 1). The mean body weights of the fish were 0.94±0.17g, 0.92±0.06g, and 0.82±0.05g in group I (Moina), group II (Tubifex) and group III (Rotifer), respectively. The mean body weight of *Notopterus notopterus* in group I (Moina) gradually increased during the experiment. It reached 2.64±0.16g, during 60 days of the study period. However, the mean body weights of fish in group II (Tubifex) 2.54±0.06g and group III (Rotifer) 2.30±0.31g were lower than in group I (Moina) (Fig. 2).

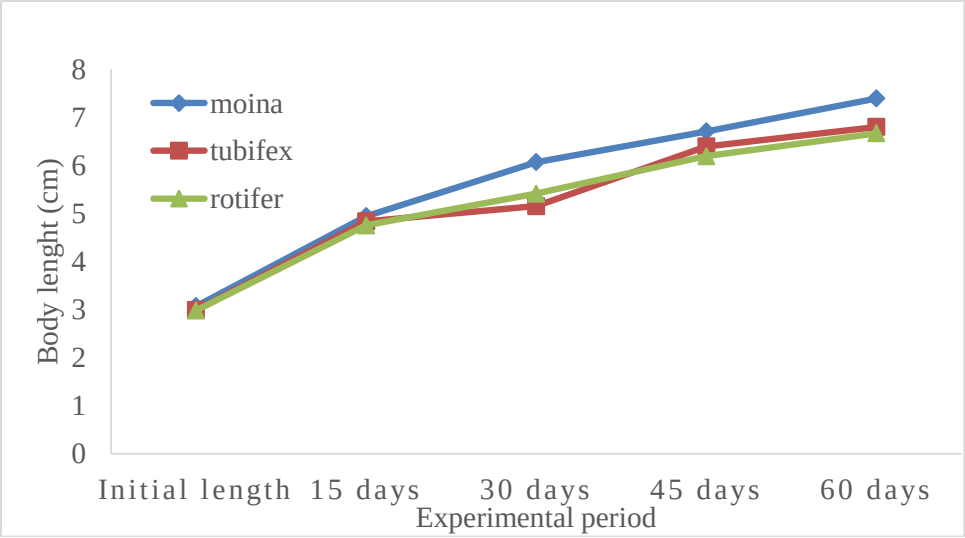

Figure. 1. Mean body length of *Notopterus notopterus* during experiment

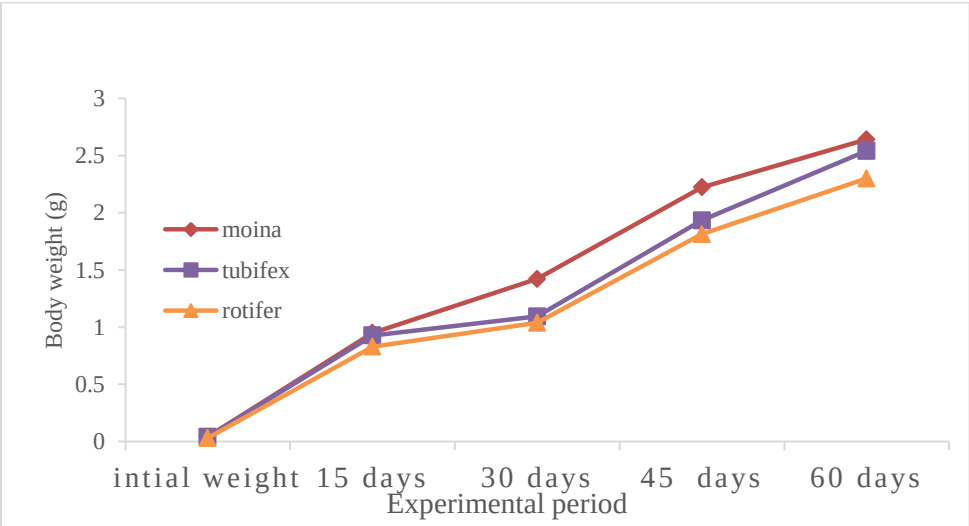

Figure. 2. Mean body weight of *Notopterus notopterus* during experiment

Specific Growth Rate and Weight Gain

The specific growth rate (SGR) was calculated to determine the growth performance during the experimental period. A high SGR was observed for larvae fed on Moina

showing an average of (6.98±0.10)g/day, followed by Tubifex (6.92±0.04)g/day while the lowest value of SGR was found in Rotifer (6.74±0.44) g/day. The highest weight gain was also found in Moina (13.96±0.20)g followed by Tubifex (13.83±0.08)g and Rotifer (13.48±0.44)g. (Table 3)

Table 3. Mean length, weight, weight gain, SGR, survival of *Notopterus notopterus* post larvae treated with three different live food diets

Parameters	Feeds		
	Moina	**Tubifex**	**Rotifer**
Initial Length (cm)	3.07±0.53	2.99±0.47	2.98±0.43
Final length (cm)	7.39 ± 0.25.	6.79 ± 0.41	6.76±0.34
Initial weight (g)	0.04±0.02	0.04±0.02	0.03±001
Final weight (g)	2.64±0.16	2.54±0.06	2.30±0.31
Weight gain (%)	13.96±0.20	13.83±0.08	13.48±0.44
SGR (%)	6.98±0.10	6.92±0.04	6.74±0.44
Survival rates(%)	83	75	82

Survival Rate

The survival rates of Notopterus notopterus post-larvae fed on three different diets during the experimental period varied from to 75% to 83% . The results indicated that maximum survivability for Moina was (83%) followed by Rotifer (82%). The lowest survival rate was recorded in Tubifex (75%).

Figure. 5. Survival rate (%) of *Notopterus notopterus* post larvae during the experiment

Water Quality

Water quality was monitored to provide an overview of changes in the experimental tanks during the study period. No remarkable variation in water quality parameter was observed. The dissolved oxygen level in the rearing tank was observed 6.23 ppm to 6.48 ppm while pH ranged from 6.6 to 7.25 and temperatures varies from 23.7 °C to 27.3°C. (Table 4)

Table 4. 6 Mean of water parameters of tanks during the experimental period

Treatment	November			December		
	Dissolved oxygen (ppm)	pH	Temperature (°C)	Dissolved oxygen (ppm)	pH	Temperature (°C)
Moina	6.48±0.02	6.86±0.01	26.3±0.02	6.34±0.02	6.6±0.02	23.7±0.03
Tubifex	6.34±0.01	7.25±0.02	26.5±0.02	6.45±0.02	7.28±0.02	24.3±0.01
Rotifer	6.23±0.02	6.6±0.01	27.3±0.01	6.28±0.02	6.6±0.02	24.8±0.02

Discussion

The featherback fish is a highly demanded freshwater fish species and therefore has excellent potential for culture (Sontakke, *et al.,* 2019). To expand featherback fish culture, understanding early larval development and feeding is imperative. However, the feeding and larval development of this fish species are poorly understood, and only a few studies have been conducted on it. Many factors are related to feeding, such as stocking density, production system, type and size of rearing tanks, size of fish, and quality and quantity of food (Mgay and Mercer, 1995).

In the present study, the growth performance of *Notopterus notopterus* larvae was evaluated using three different types of diets Moina, Tubifex and Rotifer. The study revealed differences in the growth, SGR, and survival of *Notopterus notopterus* when fed with different diets. Studies conducted so far revealed that fish larvae were generally physiologically immature, with little or no capacity to produce certain hormones and digestive enzymes. They were dependent, to a greater or lesser extent, on exogenous sources of food, including the mother and/or live food (Lam, 1994). According to Seidgar (2014), the use of live food was considered one of the prerequisites for the larval stage culture of most aquatic animals, as it provides nutritional feeding sources that are also economically cost-effective.

Common live foods used in the economic rearing of fish larvae usually include macro and microlive food, such as Moina, Daphnia, Artemia, Tubifex, Bloodworm, Mosquito larvae, and Rotifers. According to the experiment, growth parameters and weight gain were highest with live Moina (13.96±0.20)g, followed by Tubifex (13.83±0.08)g and Rotifer (13.48±0.44)g. A similar finding was observed by Sontakke *et al*., (2019), where growth parameters and weight gain were higher in Moina (22.9±0.08) g compared to live Tubifex (22.6±0.11) g treated with *Notopterus chitala*. The study indicated that the post larvae of *Notopterus notopterus* were successfully weaned onto Moina, Tubifex, and Rotifer in an experimental setting. Moina, Tubifex, and Rotifer were proven to be excellent feeds for the post-larvae rearing of *Notopterus notopterus* in terms of growth. It is interesting to note that Moina served as an excellent diet for rearing post larvae of *Notopterus notopterus.* According to Fluchter (1982), the growth rates of fish receiving these diets could be due in part to the physical properties of the feed.

During the rearing period, *Notopterus notopterus* exhibited sluggishness and showed schooling and hiding behavior within gravels in the rearing tanks. Sakar *et al*. (2006) closely examined weight gain percentages and specific growth rates of *Chitala chitala* indicated a significant difference ($p<0.05$) when using zooplankton, Daphnia, and boiled egg yolk as feed. In the present study, it was noted that Moina served as an excellent diet for rearing post-larvae of *Notopterus notopterus*. Villegas (1990) reported that Moina was known to be suitable as a feed for *Chanos chanos*. Several hypotheses have been proposed to explain the low effectiveness of a dry diet as the sole food supply for fish larvae, as different larval stages have specific nutritional requirements. The present study also confirmed the feasibility of using a Moina to feed *Notopterus notopterus* post larvae.

Therefore, Moina exhibited rapid growth rates and achieved the highest final length and weight. *Moina* sp. has several advantages as a live feed in aquaculture, with its protein content averaging around 55% compared to other natural foods such as *Daphnia magna*. In the present study, higher survival rates were observed with Moina and Rotifer (83% and 82%, respectively) compared to Tubifex (75%). This finding is consistent with Sontakke *et al*., (2019) who reported higher survival rates of *Notopterus notopterus* when fed Moina (64%) and live Tubifex (62%). Many authors had shown the importance of Moina as a live feed for fish, including similar carnivorous species such as *Seriola dumerili* (Roo *et al*., 2019), Asian sea bass fry (Vartak and Singh 2009), and *Clarias gariepinus* (Achionye-Nzeh *et al*., 2012; Chepkirui-boit *et al*., 2011; Faruque *et al*., 2010; Musa, *et al*., 2012). The impact of a Rotifer diet on pikeperch (*Sander lucioperca*) significantly improved the optimum survival rate of pikeperch larvae (Yanes-Roca *et al*., 2018).

The results of the present study showed that post larvae of *Notopterus notopterus* actively fed on Moina. According to Gopakumar *et al.*, (2012) fish larvae were typically attracted to live feed due to their movement and exhibit a preference for small sized prey that fits their mouth gape. However, the effective use of live feed mainly depends on its size and nutritional content. The highest weight gain and mean weight were observed in post larvae fed live Moina (13.96±0.20)g, making it the best live feed option. Following closely was Tubifex (13.83±0.08)g, which showed a moderate weight gain, while the lowest weight gain was recorded with Rotifer (13.48±0.44)g. On day 60, the survival rate was highest at 83% for live Moina and Rotifer, while the lowest survival rate of 75% was recorded in Tubifex-fed larvae.

Conclusion

In conclusion, the present study successfully established the reliability of rearing post-larvae of *Notopterus notopterus* throughout the experiment period using three different diets. The utilization of Moina emerges as a promising option for the early life stage of featherbacks. The study emphasized the larvae's preference for Moina, due to the movement of the prey. Potential areas for further investigation, to advance conservation and aquaculture efforts for this species, include optimizing stocking density, enhancing diet presentation, adjusting feeding levels and rearing protocols, as well as developing effective feeding strategies.

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