Utilization of rotifers as natural feed in the rearing of saline nile tilapia (Oreochromis niloticus) larvae

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Abstract. After the yolk sac of fish larvae is absorbed, they will utilize external food sources such as natural phytoplankton and zooplankton. Specifically, one of the zooplankton species used is the small-sized rotifer Brachionus sp., which matches the mouth opening of the larvae. The purpose of the experiment was to examine the effects of providing live rotifer in combination with artificial feed on the survival rate and growth of Nile tilapia (*Oreochromis niloticus*) larvae in high salinity conditions. The Nile tilapia larvae used in the experiment were the offspring of Red Nifi strain breeders raised in freshwater and still containing yolk sacs. Feeding commenced after the yolk sacs were absorbed, and the salinity was gradually increased to 25-30 ppt. The larvae were fed with rotifers for seven days (P-1), 14 days (P-2), and then continued with another type of artificial feed. There was also a control group that only received artificial feed without rotifers. The stocking density of the fish larvae was 25 individuals per liter, and the total water volume used was 15 liters. The rotifer dose was maintained at 10-20 individuals per milliliter of water per day during the 4-week rearing period. The results showed that providing rotifers in water salinity between 10-15 ppt during the first seven days resulted in a survival rate of > 80%, whereas the control group achieved > 90% survival. However, the survival rate of the larvae started to decline from the second seven-day period with the increase in salinity between 15-25 ppt, and it continued to decrease to < 60% until the fourth week for all treatments.

1 Introduction

The tilapia fish, including the Nile tilapia (*Oreochromis niloticus*), is an important food source in both tropical and subtropical countries, with various species being cultivated [1]. Due to its high tolerance to extreme environmental conditions, rapid growth, and disease resistance, this fish is suitable for aquaculture development [1]

Nile tilapia is euryhaline, which means it can easily adapt to freshwater, brackish, and marine waters [2]. During its early development, newly hatched fish larvae are equipped with yolk sacs as their main source of nutrition until the yolk is absorbed. When the yolk is

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depleted, this period becomes critical as the larvae need to find natural food sources from outside their bodies, such as various types of phytoplankton and zooplankton, before transitioning to artificial feed [3].

Fish require small-sized live feed for their nutrition as it is easily digestible and rich in protein [1]. In freshwater fish larvae, mortality can be 2.5 times higher when they start consuming artificial feed compared to live feed [4]. Fish larvae cannot initially consume supplementary feed, and all the necessary growth elements cannot be found in feed. Therefore, they must be provided with live feed [5] [1]. Natural feed is ideal for most fish larvae during the early days of rearing due to characteristics like small size, slow movement, and easy digestibility [6].

Nile tilapia (*O. niloticus*) is an omnivorous fish, primarily feeding on plankton [6], and it prefers blue-green algae and diatoms, as well as zooplankton and benthos [1]. Consumption of zooplankton, particularly rotifers, increases during the juvenile stage [6]. Successful fish fry rearing requires zooplankton, especially rotifers, as their initial food source [7]. Generally, the Brachionus sp. species of rotifer is the preferred choice for early larval feed due to its small size and slow swimming speed, making it suitable prey when larvae are not yet capable of digesting Artemia nauplii. It has a high nutritional content, particularly essential fatty acids (EPA and DHA) such as 20:5 n-3 and 22:6 n-3, which are crucial for the life of marine fish larvae [8].

Studies on the growth performance and survival of Nile tilapia larvae using natural or artificial feed have been conducted over short periods and in low salinity water. To determine the subsequent larval performance, a study was conducted on the rearing of Nile tilapia larvae using rotifer rotifer (*Brachionus* sp.) as their initial feed during the early rearing period, followed by artificial feed in high salinity water for an extended rearing period up to 30 days.

2 Material and Method

2.1 Larvae collection

Nile tilapia *(O. niloticus)* larvae are obtained through the breeding of parent Nile tilapia, specifically the red nifi strain, in freshwater media. These larvae are still in the mouth and are carefully selected to ensure they still carry yolk sacs. The larvae are acclimatized to high salinity conditions through a gradual increase in salinity. The salinity is raised to 15 ppt over a 12-hour period, followed by an additional increase to 30 ppt during the subsequent 12 hours. The surviving larvae are then utilized as subjects for further cultivation and maintenance.

2.2 Larvae rearing

In this study, Nile tilapia (*O. niloticus*) larvae were reared in indoor aquariums with aeration units. Three treatments were employed: P-1 (one week of rotifer feeding followed by three weeks of artificial feed), P-2 (two weeks of rotifer feeding followed by two weeks of artificial feed), and P-3 (four weeks of artificial feed) as the control. Each treatment was replicated three times. Larval stocking density was maintained at 25 individuals per liter, and each aquarium contained 15 liters of water. The rearing period spanned four weeks (30 days).

Rotifer feeding was initiated after each water change, with the volume replaced equivalent to the amount siphoned during waste removal. Rotifer density ranged from 10 to 20 individuals per milliliter of water per day, with feeding occurring once in the morning. During the first week, 10 individuals per milliliter per day were provided (for P-1 and P-2), which was increased to 20 individuals per milliliter per day during the second week (for P-2). Chlorella was introduced into the larval-rearing medium specifically to serve as rotifer feed.

The artificial feed, in the form of fine powder with a protein content of 31-33%, was administered at a rate of 20% of the biomass, given twice daily in the morning (08:00) and afternoon (16:00) after the rotifer feeding period. Following the rotifer feeding period, water changes were performed. A 20% water change occurred in the second week, followed by 50% changes in the third and fourth weeks, with two water changes per week.

Physical water quality parameters were monitored twice weekly, while rotifer and chlorella populations were assessed daily. The experiment aimed to understand how different feeding strategies influenced the growth and survival of Nile tilapia larvae in a controlled environment. Observation of larval growth by measuring length and weight every week by taking 20 samples of fish larvae from each container. Daily mortality was recorded, and the survival rate was calculated for each sampling session.

3 Result and Discussions

3.1 Larvae survival and growth

The results of survival rate observations for red nifi tilapia larvae during a 4-week rearing period with treatments of rotifer supplementation (P-1 and P-2) and a control group for all replicates are depicted in Figure 1. When rotifers were provided for 1 week followed by artificial feed for 3 weeks (P-1), the survival rates ranged from 16.0% to 87.4% (mean of 62.04% ± 32.59%), 10.9% to 83.1% (mean of 54.59% ± 31.36%), and 8.1% to 62.5% (mean of 42.73% ± 24.57%) in weeks I, II, and IV, respectively. With rotifer supplementation for 2 weeks followed by artificial feed for 2 weeks (P-2), the survival rates ranged between 89.06% and 97.32% (mean of 92.64% ± 3.46%), 56.89% and 62.75% (mean of 59.57% ± 2.41%), and 36.36% and 45.60% (mean of 41.66% ± 3.89%) in weeks I, II, and IV, respectively. In contrast, for the control group (given artificial feed for 4 weeks), the survival rates ranged from 90.6% to 94.86% (mean of 93.04% ± 1.79%), 85.7% to 93.15% (mean of 90.66% ± 3.51%), and 42.5% to 65.8% (mean of 52.85% ± 9.68%) in weeks I, II, and IV, respectively. Until the end of the larval rearing period, the control group exhibited higher survival rates compared to the P-1 and P-2 treatments. Meanwhile, the survival rates between the P-1 and P-2 treatments were relatively similar.

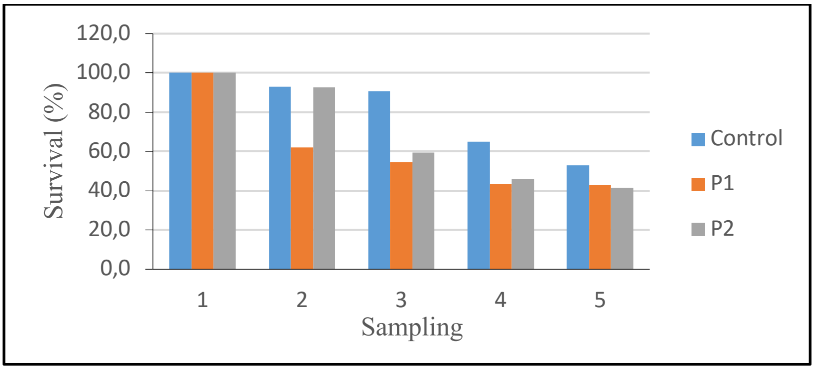

Fig. 1. Weekly sampling on survival of *O. niloticus* larvae.

The results of weight measurements of red nifi strain tilapia larvae with their respective treatments and controls are presented in Figure 2. In Treatment P-1, the weights ranged between 0.014-0.030 g/fish (average 0.026±0.002 g/fish), 0.042-0.058 g/fish (average 0.051±0.006 g/fish), and 0.095-0.109 g/fish (average 0.097±0.005 g/fish) for weeks I, II, and

IV respectively. Treatment P-2 exhibited weights between 0.022-0.026 g/fish (average 0.024±0.001 g/fish), 0.050-0.066 g/fish (average 0.058±0.006 g/fish), and 0.095-0.120 g/fish (average 0.108±0.010 g/fish) for weeks I, II, and IV respectively. Meanwhile, the control group showed weights ranging from 0.018-0.021 g/fish (average 0.020±0.001 g/fish), 0.062-0.071 g/fish (average 0.066±0.033 g/fish), and 0.115-0.127 g/fish (average 0.120±0.005 g/fish) for weeks I, II, and IV respectively. Throughout the larval rearing period, the control group exhibited greater weight increments compared to Treatment P-1 and P-2.

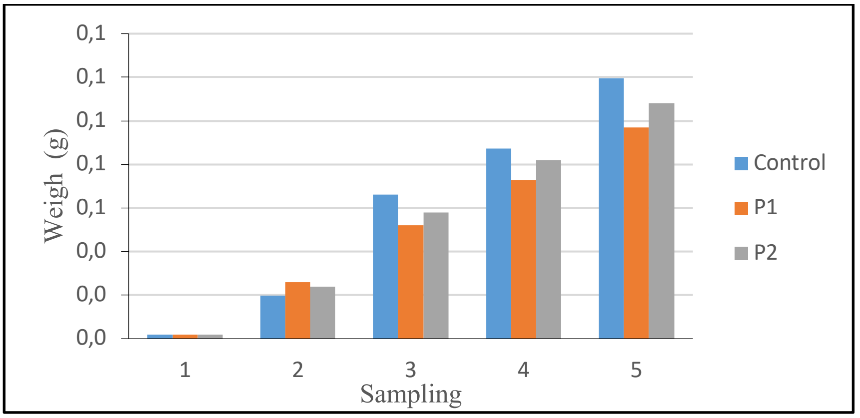

Fig. 2. Weekly sampling on individual weight of *O. niloticus* larvae.

The results of total length measurements of Nile tilapia (*O. niloticus*) larvae from each treatment and the control are presented in Figure 3. In Treatment P-1, the lengths obtained were between 1.1-1.2 cm/tail (average 1.17±0.047 cm/tail), 1.3-1.4 cm/tail (average 1.36±0.047 cm/tail), and 1.6-1.7 cm/tail (average 1.63±0.047 cm/tail) in weeks I, II, and IV respectively. For Treatment P-2, the lengths ranged from 1.10-1.21 cm/tail (average 1.17±0.049 cm/tail), 1.34-1.5 cm/tail (average 1.41±0.065 cm/tail), and 1.9-2.1 cm/tail (average 1.98±0.084 cm/tail) in weeks I, II, and IV respectively. In the control group, the lengths ranged from 1.10-1.25 cm/tail (average 1.15±0.066 cm/tail), 1.32-1.37 cm/tail (average 1.34±0.020 cm/tail), and 1.50-1.70 cm/tail (average 1.60±0.080 cm/tail) in weeks I, II, and IV respectively. Until the end of the larval rearing period, Treatment P-2 exhibited faster length growth compared to Treatment P-1 and the control.

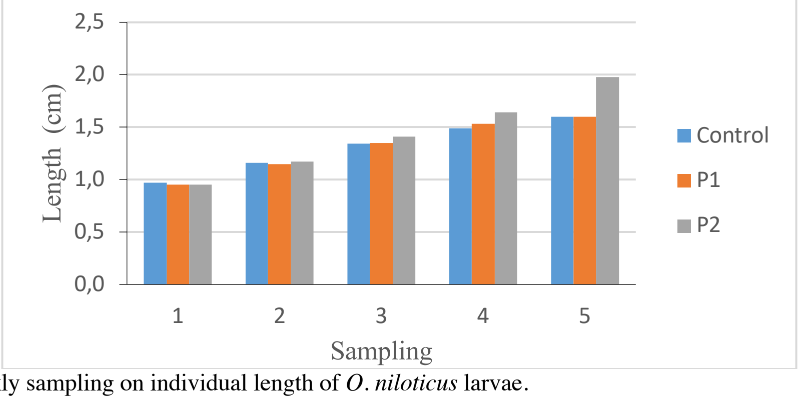

Fig. 3. Weekly sampling on individual length of *O. niloticus* larvae.

3.2 Discussion

In this testing activity, red tilapia fish larvae of the *O. niloticus* strain red nifi with remaining yolk sac containing egg yolk were used as their natural nutritional source. Once the egg yolk was absorbed, indicated by the shrinking of the yolk sac, the larvae were then provided with P-1 and P-2 treatments consisting of rotifer *Brachionus plicatilis* and artificial feed. According to [9], rotifers are commonly used as initial feed for various types of fish. These zooplankton rotifers were given as feed to the fish larvae for about a month (Paraya, 2014). The population of rotifers provided as daily feed for P-1 and P-2 ranged from 1,512,000 to 2,168,000 individuals/mL. [10] stated that omnivorous fish can survive when food concentrations in their environment are available in large amounts. In this study, the treatment of providing rotifers (P-1 and P-2) to the red tilapia fish larvae proved to be effective in utilizing them as natural feed. This is supported by the findings of [10] that Nile tilapia fish larvae of sizes 5-14 mm consume rotifers, cladocerans, and copepods. [10] also found a significant presence of rotifers and cladocerans in the digestive system of Nile tilapia fish larvae. Thus, during the initial post-larval stage, *O. niloticus* tilapia still feeds on zooplankton. [10] mentioned that adult *O. niloticus* fish stop preying on microcrustaceans and mainly consume rotifers. [10] discovered that in an environment without Nile tilapia, there is an increase in rotifer biomass. It is assumed that rotifers are likely the main food source for Nile tilapia.

In this study, red tilapia fish larvae were provided with live zooplankton rotifers *B. plicatilis* as feed, starting from the absorption of the egg yolk (weighing approximately 2 mg per individual) in a high salinity water medium. During the first week, the utilization of rotifers by the fish larvae was effective at water salinities of 10-15 ppt. [5] mentioned that rotifers can be mass-cultured at salinities of 10-15 ppt. Thus, this salinity range is supportive of both larval and rotifer life. After the rotifer feeding period, the larvae were then provided with artificial feed until the end of the rearing period (30 days). In the initial stages of development, fish larvae utilize phytoplankton and zooplankton as their natural feed. This study used a stocking density of 25 individuals per liter for all treatments and controls. The salinity of the rearing medium was gradually increased along with the rotifer feeding. [11] reared tilapia fish larvae *O. spylorus* with a stocking density of 20 individuals per liter and an initial weight of 7 mg/individual, providing only rotifers as feed for 4 days, followed by artificial feed. The total rearing time for the larvae was 14 days at salinities of 5-7 ppt. In Nile tilapia fish fry provided with artificial feed, phytoplankton, and zooplankton, at least 13% of the content in their stomachs was zooplankton [12], ranging from 8-13% [13].

Survival rates of the red nifi strain *O. niloticus* tilapia larvae for each treatment and control are shown in Figure 1. Rotifer feeding was conducted once a day in the morning. Overall, the survival rate of the larvae was quite high after the first week of rearing, exceeding 80% for both P-1 and P-2 treatments, and approximately 90% for the control group, all at a salinity of 10-15 ppt. After the second week, the survival rate began to decrease as the salinity of the rearing medium increased to 25 ppt, averaging 54.59% ± 31.36% for P-1 and 59.56% ± 2.41% for P-2. Meanwhile, for the control (total artificial feed) treatment, a survival rate of around 90% was achieved from the first to the second week (90.66% ± 3.51%). By the fourth week of rearing, the survival rate of the larvae continued to decrease within the range of 40-60%, with an average of 42.73% ± 24.57% for P-1, 41.66% ± 3.89% for P-2, and 59.66% ± 2.41% for the control. The study by [11] on tilapia fish larvae, given rotifer feed either alone or combined with artificial feed for 2-4 days, did not show a significant impact on survival rate. Rotifer feeding over 4 days at a salinity of 5-7 ppt resulted in a survival rate of 92.4% within 4 days, while for 2 days it was 81.75%, compared to 81.0% for the control. [12] reared Nile tilapia *O. niloticus* fish larvae from the larval stage for 100 days and obtained survival rates of approximately 25% (with natural feed) and 80-90% (with artificial feed and a combination of natural and artificial feed). [14] provided rotifers to mud crab zoea *Scylla olivacea* larvae three times a day, resulting in survival rates of 58% on the third day and 22% on the fourth day, which were higher than those from feeding once or twice. Feeding natural feed *B. plicatilis* with a crude protein content of 52%, formulated feed, pellets, and dry tubifex for 90 days of rearing did not show a significant impact on the difference in survival rates among all treatments [15]. Similar results were shown by [7] in fingerling *Clarias gariepinus* fish, where providing only artificial feed and combining it with live feed did not show a significant difference in the survival rate and growth of the fish.

4 Conclusion

The utilization of rotifers in the rearing of brackish water tilapia larvae within the salinity range of 10-15 ppt until the first week yields a survival rate of over 80%. As the rearing salinity increases to the range of 15-25 ppt, there is a decrease in the survival rate of larvae to less than 60% by the fourth week of rearing. The weight and length growth of larvae under treatment P-2 tends to be superior compared to treatment P-1, and the weight size of the control group is larger than that of treatment P-1 and P-2.

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