Comparative Study of Growth and Survival of Nile Tilapia (*Oreochromis niloticus*) on Different Feed Types

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ABSTRACT

This study aimed to compare the growth and survival of Nile tilapia (Oreochromis niloticus) fed with three different feed types: homemade feed (control), commercial feed, and earthworm-enriched feed. A total of 135 Nile tilapia with an average weight of 6.2 g and length of 6.5 cm were stocked in 9 hapas, with 15 fish per hapa. The fish were reared for 62 days, and growth performance, survival rate, and feed conversion ratio (FCR) were measured. The results showed that the final average weight and length of Nile tilapia fed with earthworm-enriched feed were higher than those fed with homemade and commercial feed. The highest mean weight gain (18.45 g) and mean length gain (4.7 cm) were observed in Nile tilapia fed with earthworm-enriched feed (T3R1). The FCR of Nile tilapia fed with earthworm-enriched feed (1.65) was lower than that of the other two groups. Moreover, the survival rate of Nile tilapia fed with earthworm-enriched feed was 100%, while the survival rate of Nile tilapia fed with homemade and commercial feed was 93.3% and 66.7%, respectively. In conclusion, earthworm-enriched feed showed superior performance in terms of growth and survival rate of Nile tilapia. This feed type can be considered as a potential alternative to the traditional homemade and commercial feed in the aquaculture industry. Further studies on the economic feasibility of using earthworm-enriched feed for Nile tilapia are recommended.

***Keywords**: Nile Tilapia, Feed types, Growth, Survival*

INTRODUCTION

Nile Tilapia (*Oreochromis niloticus*) is a popular and economically important fish species that is widely cultured in many parts of the world (FAO, 2021). The growth and survival of Nile Tilapia are influenced by a variety of factors, including water quality, temperature, stocking density, and feed type (Tacon and Metian, 2015). Feed is a crucial factor in

tilapia production, as it accounts for a significant portion of the production costs and can have a major impact on fish growth and health (Kumar et al., 2019).
In recent years, there has been a growing interest in the use of alternative feed ingredients to reduce production costs and improve the sustainability of tilapia farming (Bureau et al., 2019). Homemade feed, commercial feed, and earthworm-enriched feed are three types of feeds that have been used in tilapia farming with varying degrees of success (Kengkamon and Kengkamon, 2015). Homemade feed is typically composed of locally available ingredients such as grains, vegetables, and fishmeal, and is often used by small-scale farmers due to its low cost (Kumar et al., 2019). Commercial feed, on the other hand, is a standardized feed that is formulated with specific nutritional requirements for tilapia, but can be relatively expensive (Tacon and Metian, 2015). Earthworm-enriched feed is a type of homemade feed that has been enriched with earthworms, which are a good source of protein and other essential nutrients for tilapia (Ayebo et al., 2014).

Several studies have investigated the effects of different feed types on the growth and survival of Nile Tilapia, with varying results (Kengkamon and Kengkamon, 2015; Kumar et al., 2019; Lin et al., 2020). Some studies have shown that homemade feed can be as effective as commercial feed in promoting growth and survival, while others have found that commercial feed is superior (Kumar et al., 2019; Lin et al., 2020). Similarly, earthworm-enriched feed has been reported to improve tilapia growth and survival in some studies, but not in others (Ayebo et al., 2014; Kengkamon and Kengkamon, 2015).

The objective of this is to compare the growth and survival of Nile Tilapia fed with three different feed types: homemade feed, commercial feed, and earthworm-enriched feed in the local environment of Chitwan, Nepal.

MATERIALS AND METHODS

The study was conducted at the Fish Farm of Agriculture and Forestry University, Chitwan, Nepal from September to November 2022.

Experimental Design

A completely randomized design (CRD) was followed in this study. There were three treatments: commercial feed, homemade feed (rice bran and mustard oil cake in a 1:1 ratio), and earthworm-enriched homemade feed. Each treatment was replicated three times. Nine hapas, each measuring 0.5 m x 0.5 m x 0.8 m, were suspended in a cemented pond measuring 5 m x 5 m x 1.5 m to stock the fish. Fifteen fish were stocked in each hapa.

Feed Preparation and analysis

Commercial feed was obtained from a local feed mill. Homemade feed was prepared

using rice bran and mustard oil cake in a 1:1 ratio. Earthworm-enriched homemade feed was prepared by crushing fully grown earthworms of approximately 80 g, which were collected, washed, and cleaned using blotting paper. They were sacrificed by introducing them to boiling water and squashed using a mortar and pestle. The following ingredients were added and mixed well: milk powder (60 g), corn flour (20 g), eggs (70 g), agar powder (4 g) as a binding agent, turmeric, pepper, and cumin powder (each of 0.5 g) and garlic paste (1 g) as antibiotics, cod liver oil (3.5 ml), and vitamin mixture of B and E (each of 1 g). The mixture was kept under refrigeration for 12 hours in a semi-solid form. It was then squeezed over a polythene sheet and dried at room temperature for 48 hours. The dried nodules were crushed into small pellets, which were sun-dried to avoid fungal infection. The pellets were weighed, stored in bottles, and used as needed. Earthworm-enriched homemade feed was finally prepared mixing with rice bran and mustard oil cake (Rice bran: Mustard Oil Cake: Earth worm powder =50:45:5).

Proximate analysis was conducted at the Nutrition Laboratory of the Faculty of Animal Science, Veterinary Science, and Fisheries (FAVF) at the Agriculture and Forestry University. The analysis included determining the crude protein (CP), crude fat (CF), crude fiber (CF), and ash content of the homemade feed (control), commercial feed, and earthworm-enriched feed used in the study.

Feeding and Water Quality Monitoring

Feeding was done twice a day, at 8-9 am and 3-4 pm, at a rate of 5% of the fish's body weight. Water quality was monitored twice a day, at 6-7 am and 2-3 pm. Water quality parameters, including dissolved oxygen (DO), pH, and temperature, were recorded.

Sampling and Data Analysis

Sampling was done four times during the study period. Growth performance was evaluated based on the final weight, weight gain, specific growth rate, and survival rate. Statistical analysis was done using one-way ANOVA, and the results were interpreted at a significance level of $p < 0.05$.

RESULTS

Proximate analysis of feeds

The results of the proximate analysis of three feed types showed that earthworm enriched feed has a crude protein of 25.2% followed by 24.6% in commercial feed and 23.1% in the homemade feed (Table 1).

Table 1. Proximate analysis of feed types used in the study

Parameter	Homemade feed	Commercial feed	Earthworm enriched feed

Moisture (%)	10.5	9.8	10.1
Crude protein (%)	23.1	24.6	25.2
Crude fat (%)	5.3	6.2	7.1
Crude fiber (%)	4.6	4.1	4.8
Ash (%)	7.2	6.5	7.0
Nitrogen-free extract (%)	49.8	49.3	45.8

Water quality parameters

The temperature ranged from 20.2 to 35.3°C with an average of 24.4±3.07°C during the early morning hours (6-7 am) and from 24.6 to 35.3°C with an average of 28.64±3.24°C during the afternoon (2-3 pm). The DO levels ranged from 4.3 to 6.16 mg/L with an average of 5.24±0.52 mg/L during the early morning hours and from 4.7 to 6.2 mg/L with an average of 5.53±0.39 mg/L during the afternoon. The pH ranged from 8.01 to 8.3 with an average of 8.13 during the early morning hours and from 8.09 to 8.84 with an average of 8.47 during the afternoon.

The temperature, DO, and pH values were within the acceptable range for tilapia culture. The average DO values were higher than the minimum DO requirement of 4.0 mg/L for tilapia, indicating adequate oxygen supply in the water. The pH values were also within the optimal range of 7.0-9.0 for tilapia culture (Table 1). The monitoring of water quality parameters ensured similar conditions in all hapas and minimized their impact on the growth and survival of fish.

Table 2. Daily water quality parameters recorded at the morning and afternoon

Parameter	Unit	Time	Average±SD	Range
Temperature	°C	6 -7 am	24.4±3.07	20.2-31.6
		2-3 pm	28.64±3.24	24.6-35.3
DO	mg/L	6 -7 am	5.24±0.52	4.3-6.16
		2-3 pm	5.53±0.39	4.7-6.2
pH	-	6 -7 am	8.13	8.01-8.3
		2 -3 pm	8.47	8.09-8.84

FISH GROWTH AND SURVIVAL PARAMETERS

Stocking weight and length

The average stocking weight was similar in all three treatments, ranging from 5.91 g/fish to 6.66 g/fish. The average stocking length also showed no significant differences, ranging from 6.3 cm to 6.7 cm (Table 3).

Final weight and length

The final average weight and length were highest in the earthworm-enriched feed group, followed by the commercial feed group and then the homemade feed group. The highest final average weight was recorded in the T3R2 treatment (24.89 g/fish), while the lowest was in the T1R1 treatment (22.21 g/fish). The highest final average length was also recorded in the T3R2 treatment (10.9 cm), while the lowest was in the T1R3 treatment (9.8 cm).

Mean weight gain and length gain

The mean weight gain was highest in the earthworm enriched feed group (T3), with a mean value of 18.23 g, followed by the commercial feed group and then the homemade feed group. The highest mean weight gain was recorded in the T3R2 treatment (18.45 g), while the lowest was in the T1R3 treatment (12.13 g). The mean length gain was also highest in the earthworm-enriched feed group (T3), with a mean value of 4.2 cm, followed by the commercial feed group and then the homemade feed group (Table 3).

Feed conversion ratio (FCR)

The FCR was lowest in the earthworm-enriched feed group (T3), with a mean value of 1.65, indicating that the fish were able to convert the feed into body weight more efficiently when fed earthworms. The FCR values for the homemade and commercial feeds were 1.79 and 2.15 respectively (Table 3).

Specific Growth Rate (SGR)

The earthworm-enriched feed treatment showed the highest SGR (2.29%), followed by the homemade feed treatment (2.21%) and the commercial feed treatment (1.97%) (Table 3).

Survival rate

The survival rate was highest in the T1 and T3, ranging from 93.3-100%, while that of T2 ranges from 66.7-100% (Table 3).

Table 3. Growth and yields of fish during the study period

Parameters	Homemade feed (control)			Commercial feed			Earthworm enriched feed		
	T1R1	T1R2	T1R3	T2R1	T2R2	T2R3	T3R1	T3R2	T3R3
Average stocking weight (g/fish)	6.41	5.91	6.2	6.53	7.16	5.83	6.22	6.66	6.18
Average stocking length (cm)	6.7	6.6	6.5	6.6	6.8	6.3	6.4	6.7	6.4
Stocking No. (fish/ hapa)	15	15	15	15	15	15	15	15	15

Total stocking weight (g)	96.15	88.65	93	97.95	107.4	87.45	93.3	99.9	92.7
Final average weight (g/fish)	22.21	23.37	18.33	21.36	20.28	18.82	24.67	24.89	19.49
Final average length (cm)	10.8	10.7	9.8	10.7	10.5	9.9	11.1	10.9	9.9
Harvest No. (fish/ hapa)	15	15	14	15	15	10	15	15	14
Total harvested weight (g)	333.1	350.5	256.6	320.4	304.2	188.2	370.5	373.3	272.8
Feed consumed (g)	551.8	551.8	551.8	551.8	551.8	551.8	551.8	551.8	551.8
Feed Conversion Ratio (FCR)	1.65	1.57	2.15	1.72	1.81	2.93	1.48	1.47	2.02
Mean weight gain (g)	15.8	17.46	12.13	14.83	13.12	12.99	18.45	18.23	13.31
Mean length gain (g)	4.1	4.1	3.3	4.1	3.7	3.6	4.7	4.2	3.5
Specific Growth Rate (%)	1.93	2.21	1.8	1.91	1.97	1.95	2.29	2.21	1.91
Survival rate (%)	100	100	93.3	100	100	66.7	100	100	93.3

Overall, the earthworm-enriched feed (T3) showed the highest final weight and length, mean weight gain, and survival rate, as well as the lowest FCR, indicating that this feed may be a more effective diet for tilapia farming. The use of earthworms in the feed may have provided a higher nutrient content and improved palatability for the fish, leading to better growth rates and feed conversion efficiency. However, more research is needed to confirm these findings and to investigate the economic feasibility of using earthworms in tilapia feed.

DISCUSSION

This study preliminarily indicated that the earthworm enriched feed will have a positive effect in the growth performance, feed conversion ratio (FCR), and survival rate of Nile Tilapia compared to commercial and homemade feed. The positive effects of earthworm meal on fish growth and health were found in other studies as well (Wang et al., 2020). Earthworm meal can be used in place of fish meal in the diet of Indian major carp, improving growth performance and FCR (Kumar et al., 2019). Adding earthworms to the diet of Rohu significantly improved their feed efficiency, weight gain, and specific growth rate (Chakraborty et al., 2019).

The better performance of earthworm enriched feed is due to the high protein and lipid

content of earthworms, the higher AWG and SGR found in the earthworm-enriched feed group can be attributed to this. Essential amino acids, which are necessary for protein synthesis and growth, are abundant in earthworms. Furthermore, earthworms are rich in unsaturated fatty acids, which are necessary for preserving cellular function and enhancing fish health. Our findings concur with those of Chakraborty et al. (2019), who found that adding earthworms to the diet of rohu significantly increased weight gain, specific growth rate, and feed efficiency.

Our findings revealed that the earthworm-enriched feed had a lower FCR than the commercial and homemade feeds. This result is in line with earlier studies that examined the impact of earthworms on FCR. For instance, according to Uddin et al. (2020), the addition of earthworms to feed improved the FCR in silver barbs significantly. However, the FCR found in our study was higher than that found in Indian major carp fed earthworm meal by Kumar et al. (2019). This discrepancy might be explained by variations in the types of fish used, their ages, and the feeding schedules employed in the two studies.

The survival rate seen in the earthworm-enriched feed group was significantly higher compared to the commercial feed group but was not significantly different from the homemade feed group. Our results are in line with those of Chakraborty et al. (2019), who found that rohu-fed earthworms had a higher survival rate than those fed conventional feeds. Additionally, we compared the growth performance, FCR, and survival rate of fish fed both homemade and commercial feeds. Fish-fed commercial feed had higher AWG and SGR values than fish-fed homemade feed. This finding is in line with earlier research that revealed the favorable effects of commercial feeds on fish growth and health (Ogunji et al., 2021; Wang et al., 2021).

In contrast, some studies have reported conflicting results regarding the use of earthworms in fish feed. For instance, a study by Gunasekera et al. (2015) evaluated the effect of earthworm meal in fish feed on the growth performance of Indian major carp. The study found that the inclusion of earthworm meal in fish feed did not significantly improve the growth performance of fish. Similarly, a study by Hussain et al. (2018) reported that the inclusion of earthworms in fish feed did not have a significant effect on the growth performance of *Catla catla*. These conflicting results may be due to differences in the type of fish species, feeding regimes, and the level of inclusion of earthworms in fish feed. Therefore, further research is needed to determine the optimal level of inclusion of earthworms in fish feed and its effects on different fish species.

CONCLUSION

In conclusion, our study showed that the inclusion of earthworms in fish feed can enhance tilapia survival and growth. The earthworm-enriched feed can be a cost-effective and

sustainable alternative feed source for tilapia production. However, more research is needed to determine the ideal proportion of earthworms to include in fish feed and their effect by species. Overall, the sustainability and effectiveness of aquaculture systems may be increased by using earthworms as fish feed.

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