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Effects of Water Quality on Ectoparasite Prevalence and Intensity in the Nile Tilapia (*Oreochromis niloticus*) Aquaculture with Different Feeding Strategies

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ABSTRACT

The Nile tilapia (*Oreochromis niloticus*) is one of the most promising freshwater fish species for aquaculture in Indonesia and other tropical countries. However, one of the main challenges in tilapia farming is the frequent infestation of ectoparasites, which negatively affects fish health and growth, reducing farm productivity. Common ectoparasites found on farmed tilapia include *Trichodina* sp., *Dactylogyrus* sp., and *Gyrodactylus* sp., particularly when water quality is poorly managed. Poor water quality, including low dissolved oxygen, high concentrations of ammonia, nitrate, and nitrite, can increase the prevalence of ectoparasitic infections in tilapia, as it induces stress and the fish's immune response to pathogens. This study aimed to evaluate the effects of different feeding treatments on tilapia health and ectoparasite infestation. Conducted from February to March 2023 at the Bone Marine and Fisheries Polytechnic, the research used three feeding treatments: commercial feed, *Azolla microphylla* , and a combination of both. Water quality parameters were monitored weekly, and ectoparasite prevalence and intensity were analyzed using ANOVA and Duncan's test. Results indicated that poor water quality, particularly low dissolved oxygen, was associated with increased ectoparasite prevalence, particularly *Trichodina* sp. The study concludes that proper water management and controlled use of *Azolla microphylla* can help mitigate the prevalence of ectoparasites in tilapia farming.

INTRODUCTION

The Nile tilapia (*Oreochromis niloticus*) is one of the most promising freshwater fish species for aquaculture in Indonesia and other tropical countries. However, one of the major challenges in tilapia farming is the issue of ectoparasite infestations, which often disrupt fish health and growth, reducing aquaculture productivity. Research indicates that ectoparasites such as *Trichodina* sp., *Dactylogyrus* sp., and *Gyrodactylus* sp. are commonly found in the Nile tilapia raised in ponds, especially when water quality is not properly managed **(Suliman *et al.*, 2021)**.

Further studies reveal that poor water quality, such as low dissolved oxygen levels and high concentrations of ammonia, nitrate, and nitrite, can increase the prevalence of ectoparasite infections in the Nile tilapia **(Larasati *et al.*, 2020)**. This is due to environmental instability, which triggers stress conditions in fish, thereby reducing their immune response to pathogens. Moreover, poor water quality alters the composition of parasites found in the Nile tilapia. For example, in Yucatan, Mexico, high ectoparasite loads have been shown to significantly impact fish weight and to reduce fish condition factors by 12-15% of the profit margin per ton of fish produced **(Paredes-Trujillo *et al.*, 2021)**.

To address these issues, good water quality management is essential. A study conducted in Central Java showed that the prevalence of protozoan parasites such as *Trichodina* spp., Cryptobia spp., and Chilodonella spp. in the Nile tilapia at Mulur and Cengklik reservoirs can be reduced through proper water management and appropriate feed use **(Kolia *et al.*, 2021)**. Additionally, aquaponic systems have proven effective in improving water quality by reducing ammonia and nitrite levels, which in turn lowers fish mortality rates due to pathogenic infections such as *Aeromonas veronibiovar sobria* **(Eissa *et al.*, 2015)**.

Apart from water quality management, proper feed selection also plays a critical role in maintaining the health of the Nile tilapia. Adding fermented coconut meal to the Nile tilapia feed has been shown to reduce the prevalence of ectoparasites such as *Argulus* sp. and *Epistylis* sp. compared to the control group that did not receive the feed supplement **(Usman *et al.*, 2019)**.

Overall, optimal water quality management and the use of appropriate feed supplements can help reduce the prevalence of ectoparasite infections in the Nile tilapia, ultimately improving aquaculture yields and the quality of the fish produced. Implementing these preventive measures is crucial for sustainable Nile tilapia farming and maintaining fish health.

MATERIALS AND METHODS

This study was conducted at the Bone Marine and Fisheries Polytechnic from February to March 2023. The experimental method used consisted of three different feeding treatments: (A) commercial feed 5% of fish biomass, (B) *Azolla microphylla* feed 5% of fish biomass, and (C) a combination of commercial feed 5% and *Azolla microphylla* 5% of fish biomass. Each treatment was repeated three times, resulting in a total of nine experimental units.

The study used a completely randomized design (CRD) with nine experimental units consisting of three treatments and three replications. The Nile tilapia (8-10cm in size) were reared in concrete ponds measuring 1.462m² with a water depth of 40cm. Each pond was stocked with 20 tilapia, with the same stocking density across all units. The placement of research units was randomized to minimize bias in the results.

Pond preparation included cleaning the ponds, filling them with approximately 500 liters of water, and installing aeration to maintain dissolved oxygen availability. The Nile tilapia were sourced from UPTD BBI Taretta Amali, Bone Regency, and reared for six weeks. During the study, the fish were fed according to the treatments three times daily at 08:00, 12:00, and 16:00, with a feed amount equivalent to 5% of fish biomass.

Water quality parameters were measured weekly in the morning (07:00) and afternoon (15:30) to monitor changes in water quality parameters such as temperature, pH, and dissolved oxygen (DO). Instruments used for water quality measurement included a pH meter, DO meter, and thermometer. The water quality data were then compared to the Indonesian National Standard (SNI 7550, 2009) for the Nile tilapia farming and natural aquatic environment **(Islamy *et al.*, 2024)**.

Ectoparasite examinations were performed macroscopically and microscopically on the fish's body mucus, fins, and gills. Ten fish samples from each pond were taken at the end of the study and observed in the laboratory using a microscope. The ectoparasites observed included *Trichodina* sp., *Dactylogyrus* sp., and *Gyrodactylus* sp. Prevalence was calculated using the following formula:

$$Prevalence\ (\%) = \frac{\text{Number of infected fish}}{\text{Total number of samples}} \times 100$$

Parasite intensity was calculated using the following formula:

$$Intensity\ (individuals/fish) = \frac{\text{Total number of parasites found}}{\text{Number of infected fish}}$$

Water quality data were analyzed descriptively to observe the conformity of water quality parameters with the applicable standards. The prevalence and intensity data of ectoparasites were analyzed using analysis of variance (ANOVA) to determine significant differences between treatments, followed by Duncan's test to identify treatments with significantly different results. All data analyses were performed using SPSS for Windows version 29.

RESULTS

The water quality measurements during the study showed that the parameters of temperature, pH, and dissolved oxygen (DO) for each treatment were within the ranges specified by the Indonesian National Standard (SNI 7550, 2009) for the Nile tilapia farming. The results of the water quality measurements are presented in Table (1).

Table 1. Average water quality parameters for each treatment

Parameter	A (Commercial Feed)	B *(A. Microphylla)*	C (Combination)
Temp. (°C)	26.5 ± 0.5	26.8 ± 0.3	26.6 ± 0.4
pH	7.2 ± 0.1	7.0 ± 0.2	7.1 ± 0.1
DO (mg/L)	6.5 ± 0.6	5.8 ± 0.8	6.1 ± 0.7

In Treatment B, which used *Azolla microphylla*, the DO values were lower compared to the other treatments. This was caused by the accumulation of uneaten Azolla feed, which led to a decrease in dissolved oxygen levels. Stable water quality is crucial for maintaining fish health and preventing the occurrence of ectoparasites.

Based on the results of observations that have been made, 3 types of ectoparasites were found that infect tilapia, namely *Trichodina* sp. *Dactylogyrus* sp. and *Gyrodactylus* sp. The ectoparasites that are often found infecting the skin and gills of various freshwater fish are *Trichodina* sp. **(Rahmi, 2012)**. Furthermore, the ectoparasites that often appear in freshwater fish are *Dactylogyrus* sp. and *Gyrodactylus* sp. **(Kabata, 1985)**.

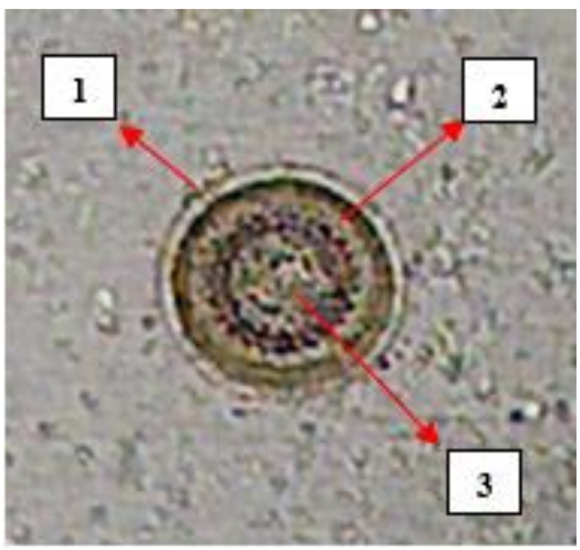

Fig. 1. Types of ectoparasites found *Trichodina* sp. 1) silia; 2) border membra; 3) dentide

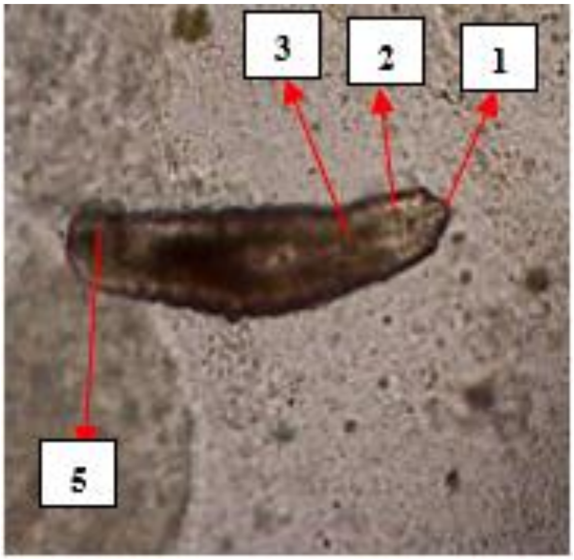

Fig. 2. Types of ectoparasites found *Dactylogyrus* sp. 1) head; 2) eye spot; 3) pharynx; 4) hook

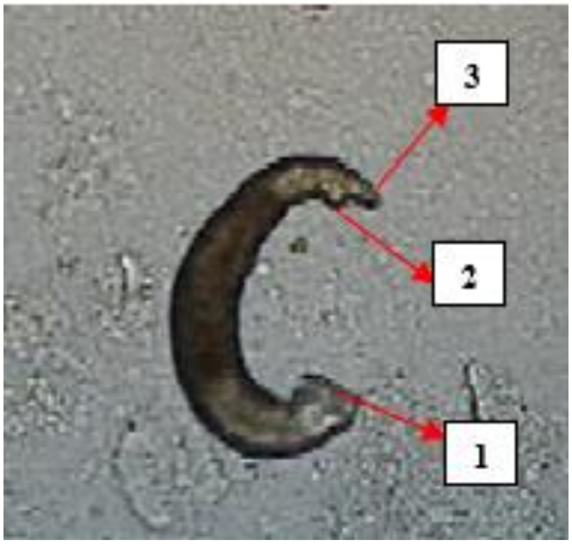

Fig. 3. Types of ectoparasites found (c) *Gyrodactylus* sp. 1) head; 2) anchor; 3) hook

The observations indicated that the ectoparasite species found were *Trichodina* sp., *Dactylogyrus* sp., and *Gyrodactylus* sp. The prevalence and intensity of ectoparasite infestations in each treatment are shown in Table (2).

Table 2. Analysis of ectoparasite prevalence and intensity for each treatment

Ectoparasite species	Treatments	Prevalence (%)	Intensity (individuals/ fish)
Trichodina sp.	A	60.0 ± 17.3	6.7 ± 22.1
	B	86.7 ± 26.6	5.1 ± 5.5
	C	80.0 ± 20.0	6.7 ± 23.8
Dactylogyrus sp.	A	60.0 ± 20.0	3.7 ± 12.4
	B	46.7 ± 15.7	3.9 ± 6.4
	C	46.7 ± 11.5	3.0 ± 2.8
Gyrodactylus sp.	A	36.7 ± 15.2	5.1 ± 11.8
	B	36.7 ± 5.7	4.5 ± 6.2
	C	43.3 ± 25.1	2.8 ± 5.7

Based on the ANOVA test results, the prevalence and intensity of ectoparasite infestations in the Nile tilapia did not show significant differences between treatments (Sig. > 0.05). This indicates that different feeding treatments did not significantly affect the prevalence and intensity of ectoparasites in tilapia.

The highest prevalence of ectoparasites in the Nile tilapia was found for *Trichodina* sp., reaching 86.7% in the treatment with *Azolla microphylla* feed. Research suggests that *Trichodina* sp. prevalence can be influenced by various factors, including the type of feed used.

Another factor affecting the prevalence of *Trichodina* sp. is water quality and environmental conditions. A study conducted in Tanzania showed that *Trichodina* sp. prevalence was higher in ponds managed with suboptimal water management, particularly in urban areas with higher organic loads **(Mathew *et al.*, 2014)**. This is consistent with findings in Indonesian fish ponds, where the accumulation of undigested feed, particularly feed with high fiber content like *Azolla microphylla* , tends to create an ideal substrate for the growth of *Trichodina* sp. and increase the prevalence of infections.

Additionally, research in Brazil has shown that the prevalence of *Trichodina* sp. is also influenced by seasonal factors. The prevalence of *Trichodina* sp. infections is higher during the dry season than the rainy season. This is due to significant changes in water quality parameters, such as temperature, dissolved oxygen, and pH, during the dry season, which create conditions favorable for parasite growth **(Zago *et al.*, 2014)**.

Another study in Central Java, Indonesia, found that *Trichodina* sp. prevalence was very high in tilapia cultivated in certain reservoirs. The highest prevalence was found in Mulur Reservoir at 90.4%, followed by Cengklik and Gajah Mungkur Reservoirs. Environmental factors and fish farming management in floating cages contributed to the high infection rates of *Trichodina* sp. in these locations **(Kolia *et al.*, 2021)**.

The high prevalence of *Trichodina* sp. in the *Azolla microphylla* feed treatment (B) suggests that the accumulation of organic matter from uneaten feed creates environmental conditions conducive to ectoparasite development. Studies have shown that *Trichodina* sp. can proliferate rapidly in waters with high organic content and poor water quality, such as low dissolved oxygen (DO) levels **(Larasati *et al.*, 2020)**. This condition leads to an increase in microorganism populations that act as vectors for this parasite, causing its prevalence to rise in organic-rich waters.

Trichodina sp. typically attacks the mucus layer on the skin and gills of fish, causing irritation and reducing the fish's ability to absorb oxygen from the water. The study in Tanzania indicated that *Trichodina* sp. prevalence was higher in ponds with poor water management, particularly in urban areas with higher organic pollution levels, demonstrating the critical role water quality plays in ectoparasite spread in the Nile tilapia farming **(Mathew *et al.*, 2014)**.

Furthermore, in the combination feed treatment (C), the prevalence and intensity of *Trichodina* sp. remained high. The combination of *Azolla microphylla* and commercial feed resulted in higher feed waste, despite being nutritionally more complete. The organic matter from both types of feed tends to accumulate at the pond bottom, creating an environment conducive to parasite development. Research in Brazil showed that *Trichodina* sp. prevalence tends to increase during the dry season when water quality declines and DO levels drop, making fish more susceptible to infections **(Ribeiro *et al.*, 2022)**.

Organic matter accumulation from uneaten feed not only increases the organic load but also provides an ideal substrate for the development of ectoparasites like *Trichodina* sp., especially in waters with declining quality, such as low DO levels and high nitrite content. Another study in Guerrero, Mexico, found that *Trichodina* sp. prevalence reached 32.22% in water bodies contaminated with high organic matter, primarily due to pollution from major water sources like the Balsas and Cutzamala Rivers **(Sarabia *et al.*, 2018)**.

In the commercial feed treatment (A), although the intensity of ectoparasite infestations was also high, the prevalence of *Trichodina* sp. tended to be lower compared to treatment B. Research indicates that commercial feed generally has a formula that is more easily digested and absorbed by fish, resulting in less organic matter accumulation at the pond bottom. High-quality commercial feed is designed to minimize leftover residues in the water, helping maintain better water quality and reduce the risk of ectoparasite development, including *Trichodina* sp. **(Agustina *et al.*, 2019)**.

The good water quality in the commercial feed treatment also contributed to the reduction in ectoparasite prevalence, as well-maintained aquatic environments prevent the growth of pathogenic microorganisms that serve as vectors for *Trichodina* sp. Research in Brazil showed that in water bodies with good water quality and adequate DO levels, *Trichodina* sp. prevalence was lower compared to water bodies contaminated with high organic content **(Zago *et al.*, 2014)**.

The better water quality in treatment A compared to treatment B can be observed from the higher DO levels in treatment A. Higher DO levels indicate lower microbial activity in breaking down organic matter, reducing parasite populations in the environment. Another study in Tanzania supported this finding, showing that *Trichodina* sp. prevalence was lower in ponds with good water quality, particularly those managed with efficient water circulation systems and feed management **(Mathew *et al.*, 2014)**.

Water temperature and pH play important roles in influencing the presence and development of ectoparasites in the Nile tilapia (*Oreochromis niloticus*). Research indicates that a stable temperature in the range of 26-28°C supports the growth of *Trichodina* sp., especially in densely stocked tilapia farming environments. A study conducted in Surabaya, Indonesia, found a positive correlation between temperature, pH, and *Trichodina* sp. prevalence, indicating that rising temperatures and pH changes can trigger an increase in parasite numbers in aquatic environments **(Larasati *et al.*, 2020)**.

Additionally, research in Brazil found that *Trichodina* sp. was more prevalent during the dry season when water temperatures were higher and pH remained stable between 7 and 8.5. These environmental factors caused ectoparasites to proliferate more rapidly compared to the rainy season when temperatures were lower, and pH fluctuations were more significant **(Zago *et al.*, 2014)**.

The optimal pH for the Nile tilapia is between 6.5 and 7.5, supporting maximum fish growth. However, if there is a slight change in pH due to the accumulation of organic matter, parasites like *Trichodina* sp. can quickly adapt and increase their population in the environment. Another study in Behera, Egypt, found that *Trichodina* sp. prevalence increased at optimal temperatures and pH, but poor water quality due to organic matter accumulation could worsen the infection's impact on fish, leading to damage to the fish's gill and skin tissues **(Khallaf *et al.*, 2020)**.

Therefore, maintaining good water quality with stable temperatures and controlled pH levels is crucial for suppressing the growth of ectoparasites such as *Trichodina* sp. in the Nile tilapia aquaculture. Routine monitoring of water quality parameters such as temperature, pH, dissolved oxygen (DO), and organic matter is necessary to prevent conditions that support ectoparasite growth.

Further research is required to evaluate the immune responses of tilapia when fed with diets or supplements formulated from natural ingredients. Numerous natural materials have been investigated by previous researchers for their potential as immunostimulants in aquaculture. Several nutrient-rich natural ingredients have been identified, including various species of seaweeds **(Kilawati & Islamy, 2019; Islamy *et al.*, 2024; Islamy *et al.*, 2024; Islamy *et al.*, 2025)**, neem leaves (*Azadirachta indica*) **(Islamy *et al.*, 2024a)**, *Ipomoea pes-caprae* **(Islamy *et al.*, 2024b)**, and other plant-based additives **(Islamy *et al.*, 2024; Kilawati *et al.*, 2024)** in addition to alligator weed

(*Alternanthera philoxeroides*) **(Serdiati *et al.*, 2024)**. Exploring the integration of these natural additives within different aquaculture systems may offer valuable insights into optimizing fish nutrition, enhancing immune performance and reproductive success, as well as boosting overall aquaculture productivity.

In addition, challenge tests using Acute Hepatopancreatic Necrosis Disease (AHPND) may also be conducted to evaluate the efficacy of natural feed additives in enhancing disease resistance. Further research is also needed involving both local and non-local aquatic species, as previously reported in published studies, such as the Red devil cichlid **(Jatayu *et al.*, 2023)**, *Nemacheilus* spp. **(Valen *et al.*, 2024)**, *Xiphophorus helleri* **(Islamy *et al.*, 2025),** Midas cichlid **(Islamy *et al.*, 2025)**, and *Gambusia affinis* (mosquitofish) **(Syarif *et al.*, 2025)**. The application of challenge agents, including pathogenic bacteria such as *Aeromonas* spp. **(Islamy, 2019)** and viral pathogens **(Kilawati *et al.*, 2024; Kilawati *et al.*, 2025)** is essential. Such studies should employ well-established indicator parameters, as described in published literature, including histopathological alterations of the hepatopancreas and intestines, molecular identification, and hemocyanin gene (HMC) characterization **(Kilawati *et al.*, 2024; Kilawati *et al.*, 2025)**.

CONCLUSION

Good water quality, particularly stable dissolved oxygen levels and low organic matter accumulation, is crucial in preventing ectoparasite infestations in the Nile tilapia. The use of *Azolla microphylla* as feed tends to increase ectoparasite prevalence compared to commercial feed, although it can be used as an alternative with certain limitations, such as adjusting feeding frequency and regularly monitoring water quality.

To minimize the prevalence and intensity of ectoparasite infestations in the Nile tilapia, it is recommended to use *Azolla microphylla* feed in limited amounts or combine it with commercial feed, adjusting the feeding frequency to prevent organic matter buildup at the pond bottom. Regular monitoring of water quality, particularly dissolved oxygen levels, along with the implementation of good water management practices, can help suppress ectoparasite development and maintain the health of Nile tilapia throughout the cultivation period.

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