



## Efficiency of Utilizing the Nile Tilapia and Catfish Aquaculture Wastewater in Enhancing Growth Performance of the Freshwater Prawns (*Macrobrachium lanchesteri*)

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### ABSTRACT

Freshwater prawns (*Macrobrachium lanchesteri*) play a vital role in aquaculture and aquatic ecosystems. This study investigates the use of wastewater from the Nile tilapia (*Oreochromis niloticus*) and catfish (*Clarias gariepinus*) aquaculture to improve water quality and enhance the growth performance of freshwater prawns. The 30-day experiment, conducted at the Basic Science Laboratory, PSDKU UB, Kediri Campus, monitored water quality parameters (pH, dissolved oxygen, ammonia, nitrite, nitrate, temperature, total suspended solids) and assessed prawn growth (weight gain, specific growth rate, survival rate, and condition factor). Results showed that prawns in the Tilapia Wastewater group exhibited the highest median weight gain (2.1 g), significantly outperforming both the Control (1.0 g) and Catfish Wastewater (1.75 g) groups ( $P < 0.05$ ). The specific growth rate (SGR) was also higher in the Tilapia Wastewater group (350.0), compared to the Control (226.9) and Catfish Wastewater (318.2) groups ( $P < 0.05$ ). Positive correlations were observed between ammonia (0.588), nitrite (0.285), and nitrate (0.929) levels and prawn growth. These findings suggest that the integration of aquaculture wastewater, particularly from tilapia farming, can significantly improve prawn growth and survival. By optimizing nutrient recycling and microbial interactions, this approach reduces reliance on freshwater and promotes environmental sustainability in aquaculture systems. The study highlights the potential for wastewater reuse in enhancing aquaculture productivity and sustainability, offering an eco-friendly solution for commercial aquaculture operations.

### INTRODUCTION

Freshwater prawns, commonly found in rivers and streams, play a crucial role in both natural aquatic ecosystems and human livelihoods. These prawns serve as a vital component of the aquatic food chain, providing a natural and nutrient-rich food source

for various predatory fish species (**Wangda *et al.*, 2023**). In aquaculture, the use of river prawns as live feed has been recognized for its potential to enhance fish growth, improve feed efficiency, and contribute to sustainable fish farming practices (**Silva *et al.*, 2020**).

Beyond their role in aquaculture, freshwater prawns also hold significant economic and nutritional value for human consumption. In many regions, these prawns are harvested from wild capture fisheries or aquaculture to meet the demand for high-protein food sources (**Suday, 2020**). Their delicate texture, rich flavor, and high nutritional content, including essential amino acids and omega-3 fatty acids, make them a popular choice among consumers. Additionally, the sustainable harvesting and cultivation of river prawns can contribute to rural livelihoods, food security, and the economic development of local communities (**FAO, 2020**).

Despite their importance, challenges persist in the sustainable utilization of freshwater prawns. Overfishing, habitat degradation, and climate change have impacted the natural populations of these species, raising concerns about their long-term availability (**Kumar, 2020**). Furthermore, the potential of integrating freshwater prawns into aquaculture systems remains underexplored in many regions. Addressing these challenges requires comprehensive research on the ecological role, optimal farming practices, and sustainable management of river prawn populations (**Silva *et al.*, 2020**).

Aquaculture wastewater, particularly from the farming of the Nile tilapia (*Oreochromis niloticus*) and catfish (*Clarias gariepinus*), contains high concentrations of organic matter, nitrogen, and phosphorus, which can contribute to water pollution if not managed properly (**Wei *et al.*, 2025a**). Effluents from aquaculture ponds are often rich in uneaten feed, fish excretions, and other organic residues that accumulate over time. If discharged into the environment without proper treatment, these substances can lead to eutrophication, reducing water quality and negatively impacting aquatic biodiversity (**Fadjar *et al.*, 2025**).

However, these nutrient-rich effluents have potential benefits when repurposed in an integrated aquaculture system. The use of aquaculture wastewater in polyculture systems has been shown to support the growth of secondary aquatic organisms, such as freshwater prawns, by providing an organic and nutrient-dense environment (**Rahmah *et al.*, 2022**). This approach not only reduces environmental pollution but also enhances the efficiency of water use in aquaculture operations. By leveraging these wastewater resources, it is possible to create a sustainable and circular aquaculture system that minimizes waste while optimizing production efficiency.

This study aims to explore the efficiency of utilizing wastewater from the Nile tilapia (*Oreochromis niloticus*) and catfish (*Clarias gariepinus*) aquaculture on water quality and the growth performance of freshwater prawns (*Macrobrachium lanchesteri*). By examining the impact of wastewater reuse in aquaculture systems, this research seeks to provide insights into sustainable strategies for optimizing aquaculture waste management while improving the production of river prawns. The findings of this study are expected

to contribute to the development of more efficient and environmentally friendly aquaculture practices while ensuring the conservation of freshwater prawn populations for future generations.

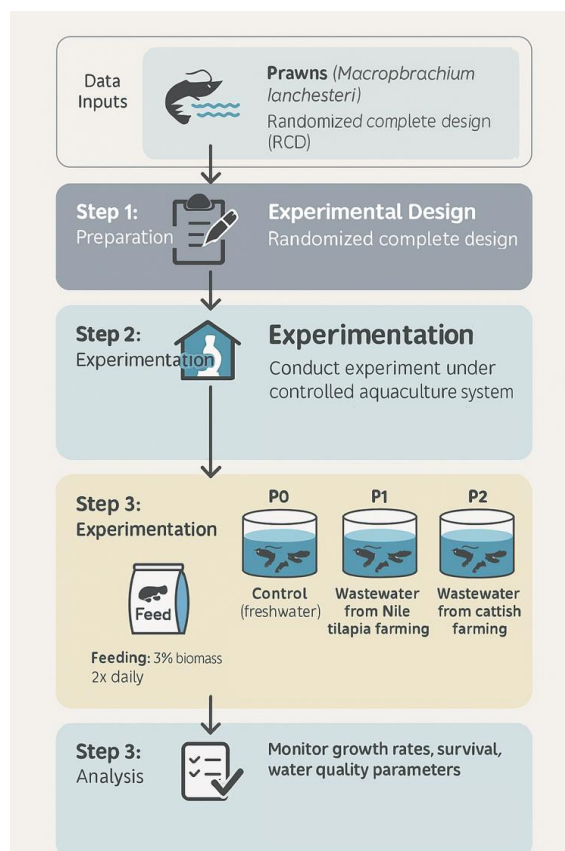
## MATERIALS AND METHODS

### Ethical Statement

All procedures and methods used in this study were approved by the Ethical Commission of Universitas Brawijaya and followed the ethical guidelines set by the Animal Behavior Society.

### Experimental design and experimental units

The study employed a randomized complete design (RCD) to assess the effects of different water sources on the growth and survival of freshwater prawns (*Macrobrachium lanchesteri*). The experiment consisted of three treatments and one control, each replicated three times to ensure statistical reliability. The treatments included P0 (control), which utilized freshwater without aquaculture wastewater, P1, which incorporated wastewater from the Nile tilapia (*Oreochromis niloticus*) farming, and P2, which utilized wastewater from catfish (*Clarias gariepinus*) farming. Each experimental unit was stocked with 50 individuals, allowing for a standardized evaluation of growth performance, water quality parameters, and overall survival rates.



**Fig. 1.** A graphical depiction of the modeling approach used in this study

The research was conducted at the basic science laboratory, PSDKU UB, Kediri Campus, under a controlled aquaculture system to maintain environmental stability and to minimize external variability. The study spanned 30 days, with systematic and periodic data collection to monitor key parameters such as water quality (pH, dissolved oxygen (DO), ammonia ( $\text{NH}_3$ ), nitrite ( $\text{NO}_2^-$ ), nitrate ( $\text{NO}_3^-$ ), temperature), prawn survival rates, and growth performance metrics. Water quality parameters were measured at regular intervals to assess the impact of different wastewater sources on the aquatic environment and the physiological response of *M. Lanchesteri*.

The freshwater prawns were offered extruded commercial pellets. To start, the amount of feed was set at 3% of the prawn biomass, with daily observations to ensure the prawns consumed the feed within five minutes. They were fed twice daily, at 08:00 and 17:00 hours. Instead of a specific feed, the prawns relied on the remaining fish feed for nourishment.

### Analyzed parameters

#### *Water quality parameters*

Water quality plays a pivotal role in determining the health, growth, and survival of cultured species. In this study, key water quality parameters, including pH, dissolved

oxygen (DO), ammonia (NH<sub>3</sub>), nitrite (NO<sub>2</sub><sup>-</sup>), and nitrate (NO<sub>3</sub><sup>-</sup>) were analyzed to evaluate their influence on the experimental treatments. Eminently, the water pH affects physiological processes, enzyme activity, and metabolic efficiency. While, dissolved oxygen (DO) is crucial for respiration and survival; as low DO levels can cause stress and mortality. For ammonia, nitrite, and nitrate, excessive concentrations of these compounds can be toxic, affecting growth and immune response.

### ***Specific growth rate (SGR)***

The specific growth rate (SGR) is a key metric in aquaculture used to quantify the daily percentage increase in an organism's weight over a given period. It provides insights into growth efficiency under varying environmental and dietary conditions. The SGR is calculated using the following equation:

$$SGR = (\ln W_t - \ln W_0) / t \times 100$$

Where:

W<sub>t</sub> = final weight (g)

W<sub>0</sub> = initial weight (g)

t = duration of rearing period (days)

SGR has been widely applied in evaluating growth performance in aquaculture species, allowing researchers to compare the effects of different treatments on growth efficiency. Previous studies, such as that of **Omasaki *et al.* (2017)**, utilized SGR to assess the genetic and environmental influences on the growth of the Nile tilapia.

### ***Survival rate (SR%)***

The survival rate (SR) is a fundamental indicator of aquaculture success, reflecting the proportion of organisms that survive a given experimental period. This parameter is critical in assessing the sustainability and feasibility of specific aquaculture practices. SR is determined using the equation:

$$SR = (N_t / N_0) \times 100$$

Where:

N<sub>t</sub> = number of surviving organisms at the end of the experiment

N<sub>0</sub> = initial number of organisms stocked

A high survival rate signifies a favorable cultural environment, while lower values may indicate suboptimal water quality or management practices. In this respect, **Rahman *et al.* (2019)** demonstrated the relationship between stocking density, environmental conditions, and survival rates in aquaculture species.

***Fulton's condition factor (K)***

The Fulton's condition factor (K) is used to assess the overall health, well-being, and robustness of aquatic species. It serves as a biological indicator of whether a fish or crustacean is in good condition relative to its length and weight. The formula used to calculate K is:

$$K = W / L^3 \times 100$$

Where:

W = prawn weight (g)

L = prawn length (cm)

A higher K value indicates better physiological conditions and nutritional status, whereas lower values may signal stress, malnutrition, or unfavorable environmental conditions. **Ravikumar *et al.* (2023)** extensively reviewed the application of this condition factor in stock assessment and fisheries management, reinforcing its significance in aquaculture research.

**Statistical analysis*****One-way ANOVA***

A one-way analysis of variance (ANOVA) was employed to determine if there were statistically significant differences between the means of three or more independent groups. This test partitions the total variance into variances between groups and within groups to assess the impact of the independent variable (**Gillard, 2020**).

***Post-hoc test (Tukey HSD)***

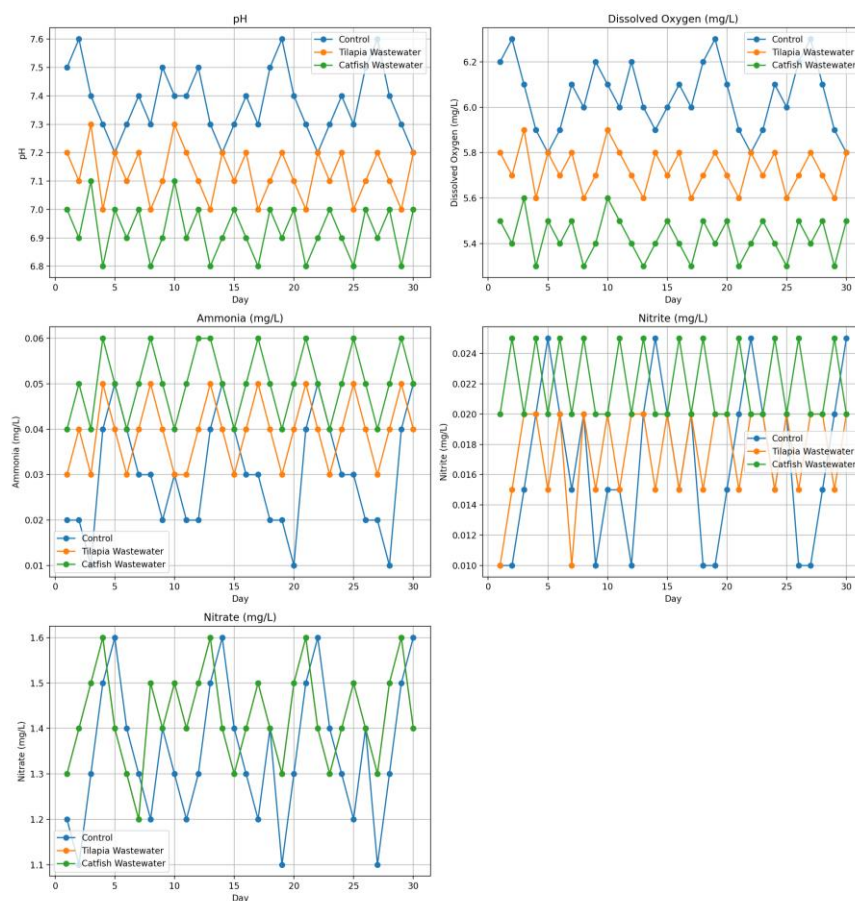
Following a significant ANOVA result, Tukey's HSD test was conducted to perform pairwise comparisons between group means, identifying specific group differences while controlling Type I errors. It assumes equal variances and normality (**Nanda *et al.*, 2021**).

***Pearson correlation***

This measures the strength and direction of the linear relationship between two continuous variables, assuming that the data were normally distributed (**Schober *et al.*, 2018**).

## RESULTS

### 1. Comparison of water quality stability and its impact on shrimp farming



**Fig. 2.** Water quality parameters by treatment group

The water quality parameters, including pH, dissolved oxygen (DO), ammonia, nitrite, and nitrate, showed some significant differences across the treatments. pH levels in the Control group remained stable (7.2–7.6), whereas Tilapia Wastewater and Catfish Wastewater exhibited lower and more fluctuating pH values (6.8–7.2 and 6.8–7.0, respectively), with the latter indicating a more acidic environment. However, no significant differences in DO concentrations were observed between the treatments, with levels in the Control group (5.8– 6.3mg/ L) being slightly higher than those in the Tilapia Wastewater (5.3– 5.8mg/ L) and Catfish Wastewater (5.3– 5.5mg/ L).

Ammonia concentrations were significantly higher ( $P < 0.05$ ) in the Catfish Wastewater treatment (0.04– 0.06mg/ L) compared to the Control (0.01– 0.05mg/ L) and Tilapia Wastewater treatments (0.03– 0.05mg/ L). Nitrite levels fluctuated more in

Catfish Wastewater (0.02– 0.025mg/ L), while the Control and Tilapia Wastewater treatments exhibited more stable nitrite concentrations (0.01– 0.025mg/ L). Nitrate concentrations showed a slight increase in both Tilapia and Catfish Wastewater treatments (1.2– 1.6mg/ L and 1.3– 1.6mg/ L, respectively) compared to the Control (1.1– 1.6mg/ L), but these differences were not statistically significant. There was a noticeable peak in ammonia concentrations in Catfish Wastewater, reaching the highest levels by day 14, followed by a decline in the subsequent days. Nitrite levels in Tilapia Wastewater showed greater fluctuations compared to both the Control and Catfish Wastewater treatments, with peaks on days 8 and 18. Nitrate concentrations remained relatively steady in all treatments, although a slight increase was observed in the Tilapia Wastewater on day 12, surpassing the Control levels for a brief period before returning to baseline levels.

## 2. Growth performance metrics

**Table 1.** Growth performance metrics of river shrimp under different treatments

| Treat<br>ment        | In<br>itial<br>Weight<br>(g) | Fi<br>nal<br>Weight<br>(g) | I<br>nitial<br>Length<br>(cm) | F<br>inal<br>Length<br>(cm) | S<br>GR | Con<br>dition<br>Factor | F<br>CR | Su<br>rvival<br>Rate<br>(%) | W<br>eight<br>Gain<br>(g) | L<br>ength<br>Gain<br>(cm) |
|----------------------|------------------------------|----------------------------|-------------------------------|-----------------------------|---------|-------------------------|---------|-----------------------------|---------------------------|----------------------------|
| Control 1            | 50                           | 0.5                        | 1.20                          | 1.05                        | 3.0     | 20                      | 3.49    | 1                           | 90                        | 1.30                       |
| Control 2            | 52                           | 0.7                        | 1.20                          | 1.04                        | 3.6923  | 5                       | 4.32    | 9                           | 86                        | 1.20                       |
| Control 3            | 51                           | 0.8                        | 1.25                          | 1.06                        | 3.941   | 8                       | 3.85    | 7                           | 90                        | 1.35                       |
| Tilapia Wastewater 1 | 60                           | 0.7                        | 1.30                          | 1.09                        | 0.0     | 5                       | 2.29    | 5                           | 98                        | 2.60                       |
| Tilapia Wastewater 2 | 62                           | 0.6                        | 1.35                          | 1.08                        | 4.355   | 1                       | 2.35    | 6                           | 98                        | 1.45                       |
| Tilapia Wastewater 3 | 61                           | 0.8                        | 1.32                          | 1.02                        | 5.016   | 1                       | 1.99    | 5                           | 10                        | 2.88                       |
| Catfish Wastewater 1 | 55                           | 0.3                        | 1.25                          | 1.05                        | 4.182   | 4                       | 2.52    | 6                           | 94                        | 1.25                       |
| Catfish Wastewater 2 | 57                           | 0.4                        | 1.30                          | 1.06                        | 1.053   | 6                       | 2.46    | 6                           | 92                        | 1.30                       |
| Catfish Wastewater 3 | 56                           | 0.2                        | 1.28                          | 1.04                        | 2.857   | 3                       | 2.58    | 6                           | 94                        | 1.12                       |

Note: SGR (Survival Growth Rate), FCR (Feeding Concentration Rate), SR (Survival Rate), K (Condition Factor).

Shrimp in the Tilapia Wastewater group exhibited the highest median weight gain (2.1 g), significantly outperforming both the Control (1.0 g) and Catfish Wastewater

groups (1.75g) ( $P < 0.05$ ). These results highlighted the positive impact of Tilapia Wastewater on shrimp growth, with the Control group showing the lowest weight gain, which indicated limited growth under more stable but nutrient-poor conditions.

Similarly, the Control group showed the least length increase, with a median of 2.3 cm, while shrimp in the Tilapia Wastewater group had the greatest median length gain (3.6cm). The Catfish Wastewater group also exhibited a substantial median length gain (3.25cm), though not as pronounced as the Tilapia Wastewater treatment ( $P < 0.05$ ). This indicated that both wastewater treatments had provided a more favorable environment for shrimp growth compared to the Control group.

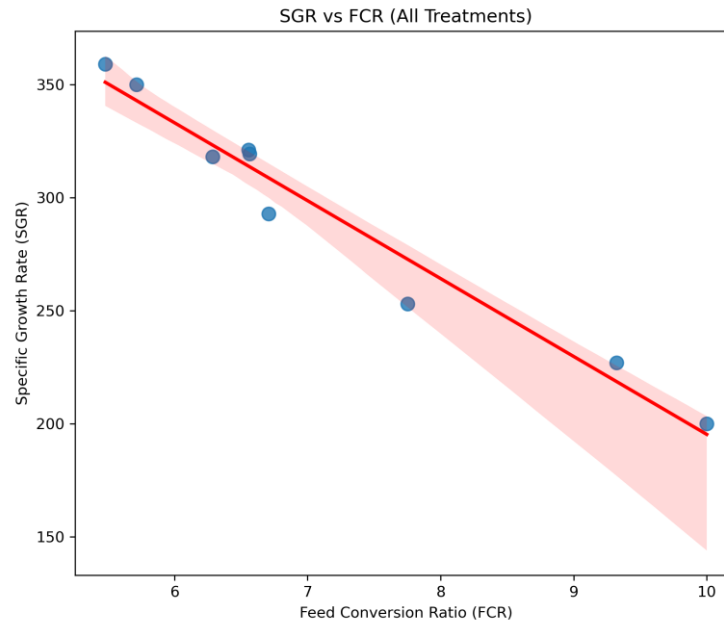
The specific growth rate (SGR) was significantly higher in the Tilapia Wastewater treatment (median SGR of 350.0), compared to the Control group (median SGR of 226.9) and the Catfish Wastewater treatment (median SGR of 318.2) ( $P < 0.05$ ). This suggested that the bioavailable nutrients and microbial populations present in Tilapia Wastewater had created an environment conducive to faster and more efficient growth. The SGR for the Control group remained considerably lower, reinforcing the superior growth conditions in wastewater treatments.

The feed conversion ratio (FCR), which reflected feed efficiency, was significantly lower in the wastewater treatments, with the Tilapia Wastewater group demonstrating the most efficient feed conversion (FCR = 5.5–5.7), followed by Catfish Wastewater (FCR = 6.3–6.7). In contrast, the Control group exhibited the least efficient feed conversion (FCR = 9.3–10.0) ( $P < 0.05$ ). These results underscored the superior feed utilization in both wastewater treatments, particularly Tilapia Wastewater, which promoted better feed efficiency and potentially lower production costs.

Survival rate (SR) was at its highest value in the Tilapia Wastewater group (94–100%), with a median of 98%, which was significantly higher than the Control group (86–90%) and the Catfish Wastewater group (92–94%) ( $P < 0.05$ ). This indicated that the Tilapia Wastewater treatment had provided the most stable and favorable conditions for shrimp survival, contributing to higher overall health and reduced mortality.

The condition factor (K), which reflected the overall health and physiological well-being of the shrimp, was the highest in the Control group ( $K = 3.5$ – $4.3$ ), indicating that despite lower feed efficiency and survival rates, shrimp in the Control treatment had accumulated more body mass relative to their length. The Catfish Wastewater group had a moderate condition factor ( $K = 2.4$ – $2.6$ ), while the Tilapia Wastewater group had the lowest condition factor ( $K = 1.9$ – $2.3$ ) ( $P > 0.05$ ). Although the differences in condition factor were less pronounced, the lower condition factor in the Tilapia Wastewater group could have been indicative of more proportional and leaner growth.

### 3.SGR versus FCR for all treatments



**Fig. 2.** Scatter plot of SGR versus FCR for all treatments

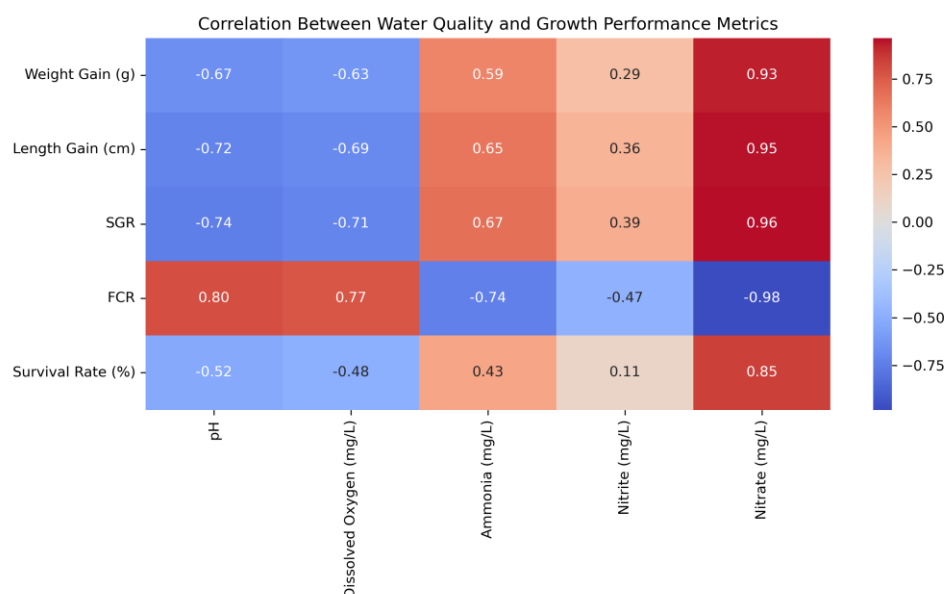
Fig. (2) presents a scatter plot showing the relationship between specific growth rate (SGR) and feed conversion ratio (FCR) across all treatments. From the analysis, it was evident that for the data from all treatments, a clear negative correlation existed, with higher FCR values correlating with lower SGR values. The plot showed that as FCR increased (indicating less efficient feed conversion), SGR decreased, highlighting the importance of improving feed efficiency for optimal growth.

However, when examining the individual treatment groups, it was apparent that the relationship was not uniform. For the Control group, the data points were more scattered, indicating less consistent growth, particularly at higher FCR values. In contrast, the Tilapia Wastewater group displayed a more concentrated distribution of data points, with most lying close to the regression line, suggesting a stronger correlation between feed efficiency and growth. The Catfish Wastewater group also showed a similar pattern to the Control group, with greater variability in SGR at higher FCR values.

When analyzing the confidence intervals (represented by the shaded regions), a distinct trend could be observed; for higher FCR values, the confidence intervals widened, indicating increased uncertainty in the estimations. This variability was especially notable in the Control and Catfish Wastewater treatments, where several data points fell outside the confidence intervals, suggesting less reliability in growth predictions. In contrast, the Tilapia Wastewater treatment showed tighter confidence intervals and a better fit to the regression line, indicating more reliable estimations for growth.

For lower FCR values, all treatments demonstrated narrower confidence intervals and more consistent growth rates, but the Tilapia Wastewater treatment maintained the tightest intervals and the least variation, reinforcing its efficiency in promoting optimal growth. This demonstrated that while feed conversion efficiency was crucial for growth, the specific water treatment used could significantly influence the reliability and consistency of growth predictions.

#### 4. Correlation of water quality parameters with growth performance metrics in aquaculture systems



**Fig. 3.** Heatmap of correlations between water quality and growth performance metrics

The results of the correlation analysis between water quality parameters and shrimp growth performance are shown in Fig. (3). The parameters with significant correlations ( $P < 0.05$ ) and their respective correlations to growth metrics were selected as key factors for this study. pH and dissolved oxygen showed negative correlations with weight gain (-0.668) and length gain (-0.633), respectively. On the other hand, ammonia (0.588), nitrite (0.285), and nitrate (0.929) exhibited positive correlations with weight gain, indicating that nitrogen compounds may have positively affected shrimp growth.

As seen in Fig. (3), while Pearson's correlation analysis revealed strong relationships between water quality parameters and growth metrics, the Random Forest feature importance scores indicated that some parameters with high correlation had relatively low contributions during the modeling process. For example, pH, with a correlation coefficient of -0.668 to weight gain, achieved a feature importance score of 0.05. Similarly, dissolved oxygen, with a correlation coefficient of -0.633 to weight gain, had a

feature importance score of 0.08. Conversely, nitrate, with a correlation coefficient of 0.929 to weight gain, achieved a higher feature importance score of 0.35. This discrepancy between high correlations and low feature importance scores suggested the need for a more nuanced approach, such as adopting a feature selection algorithm that could prioritize the most relevant parameters for shrimp growth modeling.

## DISCUSSION

The results of this study demonstrated the significant impact of aquaculture wastewater on shrimp growth and water quality management. Wastewater from tilapia and catfish farming showed distinct differences in water quality parameters, influencing shrimp growth. Specifically, ammonia and nitrite levels, which are common by-products of aquaculture, were found to correlate positively with shrimp growth. Ammonia, at moderate concentrations, provided an additional nitrogen source for phytoplankton, which then became a food source for shrimp (**Kunwong *et al.*, 2024**). This relationship highlighted the potential of aquaculture wastewater to support microbial activity that contributed to a more stable and productive environment. Nitrite and nitrate levels, similarly, played an important role in nutrient cycling, providing further benefits to the shrimp's growth. However, elevated pH and dissolved oxygen (DO) levels had a negative effect on shrimp growth, supporting findings from previous studies (**Wei *et al.*, 2025b**), which suggested that excessively high oxygen levels increased the energy demands for osmoregulation in shrimp, reducing their feed efficiency. In contrast, the microbial activity associated with low DO conditions could stimulate nutrient cycling, which, while potentially harmful to some species, appeared to positively impact shrimp growth in this study. Thus, the results underscored the delicate balance required to manage water quality in shrimp aquaculture systems.

The enhanced growth performance of shrimp in wastewater-treated systems could be attributed to the availability of natural feed sources, such as microbial biomass and phytoplankton, which thrived in nutrient-rich aquaculture water. These findings align with research by **Suzette *et al.* (2021)**, who demonstrated that biofloc, formed from aquaculture waste, could significantly improve growth rates in shrimp. Nutrient-rich wastewater from tilapia and catfish farming provided a suitable environment for biofloc formation, which was beneficial for shrimp growth by increasing the availability of microorganisms that served as a natural food source (**Arifin *et al.*, 2024**). Furthermore, the presence of organic matter in the wastewater enhanced nitrogen cycling, which supported the development of a more stable ecosystem, crucial for optimal shrimp health and productivity. As microbial communities in the wastewater broke down organic compounds, they not only aided in nutrient recycling but also provided shrimp with a readily available source of nutrition, reducing the need for artificial feed and potentially lowering operational costs (**Saufie *et al.*, 2021**).

The correlation analysis in this study revealed that ammonia and nitrite levels had a positive relationship with shrimp growth, while pH and DO levels were negatively correlated with growth. This suggested that moderate concentrations of ammonia and nitrite could enhance microbial interactions that improved nutrient availability and supported shrimp health (**Li *et al.*, 2024**). The inverse relationship between feed conversion ratio (FCR) and ammonia/nitrite levels further supported the hypothesis that microbial activity and organic matter management were key factors in optimizing feed utilization in aquaculture systems (**Kunwong *et al.*, 2024**). These findings underscored the importance of maintaining water quality parameters within optimal ranges to ensure that shrimp farming systems were both productive and sustainable. The results of this study are in line with those of previous research that highlighted the complex interplay between water quality and shrimp growth (**Fadjar *et al.*, 2025**), contributing to the growing body of literature on the role of water quality management in aquaculture.

The implications of these findings for sustainable aquaculture were significant. By utilizing wastewater from tilapia and catfish farming, shrimp farmers could reduce their dependence on freshwater resources, which was particularly valuable in regions facing water scarcity. Moreover, the use of aquaculture wastewater helped recycle nutrients, reducing environmental pollution and minimizing the need for synthetic feeds. This approach coincides with the concept of Integrated Multi-Trophic Aquaculture (IMTA), where the waste from one species was utilized by another, enhancing the efficiency of the system (**Chopin *et al.*, 2013**). The potential for wastewater reuse in shrimp farming not only offered a more sustainable alternative to conventional aquaculture practices but also provided a cost-effective solution for improving production efficiency (**Amyati *et al.*, 2020**). Additionally, the integration of advanced monitoring technologies and automated systems could optimize the management of water quality in these systems, ensuring that shrimp growth remained robust and sustainable. As demonstrated by **Kunwong *et al.* (2024)**, digital monitoring and automated controls held great promise for improving the efficiency of integrated aquaculture systems, ensuring that water quality parameters were maintained within optimal ranges.

## CONCLUSION

This study highlights that wastewater from tilapia and catfish farming can serve as a low-cost, nutrient-rich rearing medium that enhances shrimp growth and survival, promoting more sustainable aquaculture practices. Proper management of water quality parameters, along with the integration of biofloc technology and real-time monitoring, can optimize nutrient recycling and reduce reliance on freshwater resources. Future research should focus on evaluating the economic feasibility and long-term ecological impacts of wastewater-based aquaculture to ensure its viability in commercial settings.

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