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## Analysis of Fish and Water Spinach Growth in an Aquaponic System Based on the Utilization of Ablution Wastewater

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### ABSTRACT

*This study aims to analyze the growth of fish and kale plants in an aquaponic system based on the utilization of ablution wastewater as an effort to manage water sustainably in an Islamic boarding school environment. The study was conducted at the As-Salafiyah Asy-Syafi'iyah Islamic Boarding School, Tambakberas Barat, Jombang, East Java from August to October 2025. The types of fish used include Patin (Iridescent shark), Mujair (Tilapia), Gurami (Gourami), and Lele (Catfish), while the plants cultivated are kale (*Ipomoea aquatica*). Fish growth parameters were measured using Daily Weight Gain (DWG) and Specific Growth Rate (SGR), while plant growth was analyzed through Crop Growth Rate (CGR). The results showed that Mujair (Tilapia) fish had the best growth with the highest DWG of 1.71 g/day in the period 21–28 days after stocking (DAS) and the highest SGR of 21% in the period 7–14 DAS. Patin fish also showed good growth performance (DWG = 1.29 g/day; SGR = 12%), while gourami and catfish showed slower growth with DWG ranging from 0.29–0.86 g/day. Water spinach plants achieved the highest CGR of 2.14 g/day in the period 14–21 days after planting (DAP), indicating optimal vegetative growth phase.*

**Keywords:** *aquaponics, ablution wastewater, fish growth, kale, Islamic boarding schools*

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### INTRODUCTION

Increasing population growth demands the availability of sustainable food sources, both in the form of animal protein and fresh vegetables. One technological innovation that can address this challenge is the aquaponics system, an integrated cultivation system that combines fish and plants in a mutually beneficial ecosystem. Organic waste from fish farming is used as a nutrient source for the plants, while the plants act as biological filters, maintaining water quality and maintaining a healthy environment for fish life. This system is considered efficient because it can save water and land, and reduce dependence on chemical fertilizers (Hidayah & Mangitung, 2021).

Water spinach (*Ipomoea aquatica*) is a horticultural commodity that is often used in aquaponic systems because it has a high adaptability to aquatic environments, fast growth, and balanced nutrient requirements with aquaponic systems (Ramadhani et al., 2025). Furthermore, this plant has been shown to absorb ammonia and nitrate from fish culture water, thus helping to maintain stable water quality. In terms of fish, species such as catfish (*Clarias sp.*) and tilapia (*Oreochromis niloticus*) are widely used because they are tolerant of water quality fluctuations and easy to cultivate (Suryani & Rubianti, 2023).

In the context of daily Muslim life, ablution activities generate significant amounts of wastewater, particularly in Islamic boarding schools (*pesantren*) with hundreds to thousands of students. Ablution water is generally considered clean, as it is not contaminated with hazardous chemicals, but instead contains only light organic residues such as dust, natural skin oils, and fine particles (Afiatun et al., 2022). However, in many Islamic boarding schools, the ablution water is still disposed of directly into the drains without being reused, even though the amount is very significant.

Research by (Sari et al., 2018) showed that the reuse of ablution water (*recycled ablution water*) was well-received by the community because it was considered clean and suitable for non-consumption purposes such as watering plants. Similar results were also reported by (Mohamed et al., 2016) This shows that ablution water, after simple filtration, still meets irrigation water quality standards and has significant

potential for reuse and recycling. Therefore, utilizing ablution wastewater in an aquaponics system can be a concrete example of water conservation and the application of environmentally friendly technology in Islamic educational settings.

The implementation of an aquaponics system based on ablution wastewater in Islamic boarding schools is not only oriented towards efficient water use, but also towards character education and environmental awareness. As Islamic educational institutions, Islamic boarding schools play a strategic role in instilling sustainability values in their students. The eco-pesantren or green pesantren concept integrates religious activities with environmental awareness, for example by utilizing ablution water for productive activities such as agriculture. In addition to its ecological impact, this system also provides economic and educational benefits, as the fish and vegetable harvest can be used to meet the boarding school's daily consumption needs, while also serving as a learning tool for students to practice modern agricultural technology.

Based on this description, research is needed to analyze the growth of fish and kale plants in an aquaponics system based on the utilization of ablution wastewater in Islamic boarding schools. This research is expected to provide scientific and practical information regarding the feasibility of ablution water as an alternative medium in aquaponics systems, as well as serve as an example of the application of sustainable agricultural innovations and water conservation in Islamic boarding schools.

## METHOD

This research was conducted at the As-Salafiyyah Asy-Syafi'iyah Islamic Boarding School (PP) in West Tambakberas, Jombang, East Java, from August to October 2025. The aquaponics installation was made using ablution wastewater that had gone through a process based on nanotechnology filtration. The types of fish used in the aquaponics system were Iridescent shark, Tilapia, Gourami, and Catfish, while the plants used in the aquaponics system were kale. To evaluate the growth of fish, different growth parameters such as daily weight gain (g) and specific growth rate (*SGR per day*) were taken into consideration and were measured using the following formula (Nistor et al., 2020) :

$$DWG = \frac{Wf - Wi}{t}$$
$$SLA = \frac{\ln Wf - \ln Wi}{t}$$

Information: WF= Final weight of fish (g), Wi= Initial weight of fish (cm), t= Maintenance time (days).

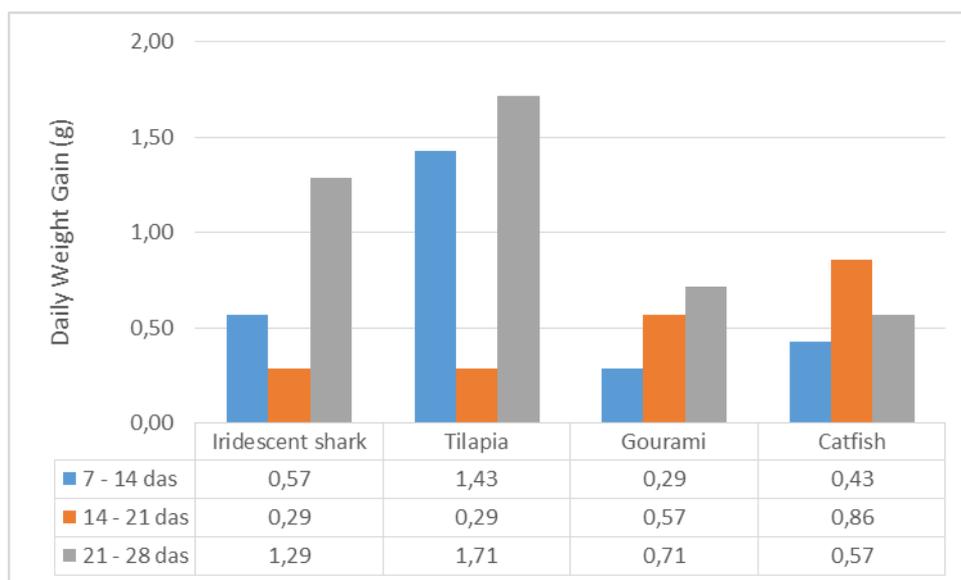
Plant growth rate is measured using the formula (Sajuri et al., 2022):

$$CGR = \frac{Wf - \ln Wi}{t}$$

Information: WF= Final plant weight (g), Wi= Initial plant weight (cm), t= Time (day)

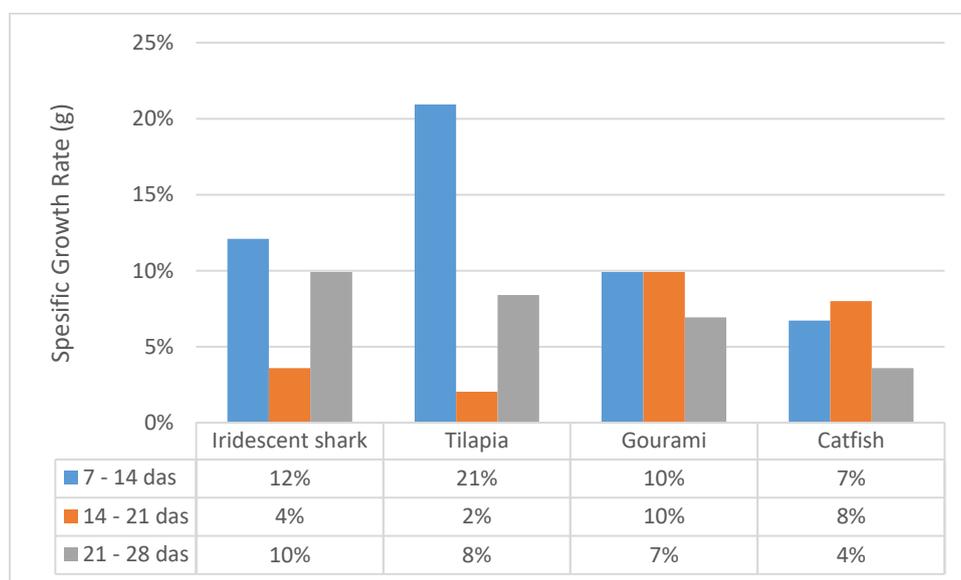
## RESULT AND DISCUSSION

The results of the study showed that Tilapia (Mujair) fish had the highest average daily growth rate of 1.14 g/day, followed by Iridescent Shark (*Patin*) at 0.72 g/day, Catfish (*Lele*) at 0.62 g/day, and Gourami (*Gurami*) at 0.52 g/day (Figure 1). The increasing growth rate in the third to fourth week (21–28 DAS) indicates that the fish began to adapt to the conditions of the water media sourced from ablution wastewater. This adaptation was characterized by increased feeding activity and metabolic efficiency, as explained by (Astuti et al., 2024) that the initial adaptation phase of fish to a new environment usually lasts 10–14 days before optimal growth occurs.



**Figure 1.** Daily weight gain of fish cultured using treated ablution wastewater

Furthermore, fluctuations in weight gain are also influenced by the stability of water quality parameters in the aquaponics system. After two weeks, the natural biofilter in the kale roots and nitrifying bacteria are working optimally, converting ammonia into nitrate, which is non-toxic to fish (Buzby & Lin, 2014). This supports increased fish growth rates in the 3rd and 4th weeks. Differences in growth rates between fish species are due to physiological differences and their ability to adapt to water quality. Tilapia are known for their rapid growth rate and high tolerance to variations in temperature, pH, and water turbidity (Selek et al., 2017). Pangasius also exhibits good growth because it can survive in low-oxygen conditions and utilizes dissolved organic matter. Conversely, gourami exhibits slower growth due to its sensitivity to fluctuations in water quality and prefers media with high oxygen levels (Sunaryani et al., 2021). Catfish grow moderately because even though they are adaptive, their growth rate is more influenced by stocking density and the availability of natural food (Armita et al., 2024).



**Figure 2.** Specific growth rate of fish cultured using treated ablution wastewater

Figure 2 shows that tilapia fish showed the highest SGR value in the initial period (7–14 DAS) at 21%, indicating a rapid growth response in the initial adaptation phase of the aquaponic system. However, in the subsequent period (14–21 DAS), the tilapia SGR value decreased drastically to 2%, presumably due to adjustments to nutrient conditions and water quality which tend to fluctuate as metabolite residues accumulate in the recirculation system. At the end of the observation (21–28 DAS), the tilapia SGR increased again to 8%, indicating good adaptation to the ablution wastewater-based maintenance medium.

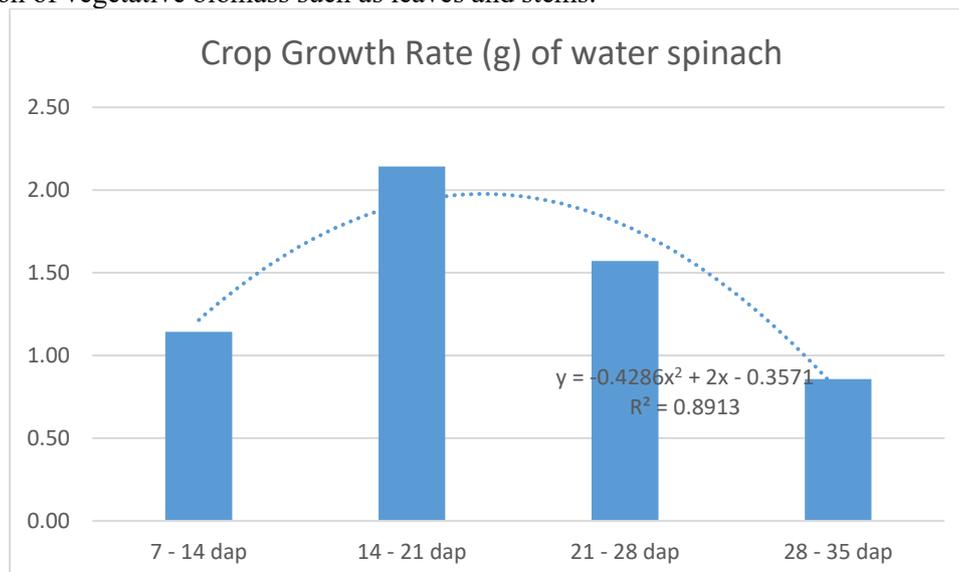
Iridescent sharks showed a relatively stable growth pattern with the highest SGR of 12% at the beginning of the observation and increased again to 10% at the end of the period, indicating the ability of

this species to adapt to environmental conditions with moderate organic matter content. Meanwhile, gourami showed a relatively stable SGR (10–7%) throughout the observation period, indicating a slow but consistent growth character. Meanwhile, catfish showed a fluctuating pattern with the highest SGR of 8% in the middle of the period (14–21 DAS) and decreased to 4% at the end of the observation, which is likely related to density factors and food competition in a closed system.

In general, these results show that tilapia and catfish have better growth performance than gourami and catfish in an aquaponic system that uses abluion wastewater as a nutrient source and water source for the rearing medium. This is in line with research findings (Rakocy, 2012) which states that Tilapia has high nutrient utilization efficiency in aquaponic systems due to its good tolerance to variations in water quality and moderate ammonia content.

The use of abluion wastewater has been proven to provide macronutrients such as nitrate ( $\text{NO}_3^-$ ) and phosphate ( $\text{PO}_4^{3-}$ ), which are essential for plant growth and help maintain the balance of the microbial ecosystem in aquaponics systems. Thus, the integration of fish and plants in a single abluion wastewater-based system supports the principles of a circular economy and sustainable water management in Islamic boarding schools (Nugroho et al., 2012).

The growth of water spinach plants in the abluion wastewater-based aquaponic system was observed based on the Crop Growth Rate (CGR) value over four observation periods. The results showed that the growth rate of water spinach plants increased significantly in the period 14–21 days after planting (DAP) with the highest CGR value of 2.14 g/day (Figure 3). This increase indicates that during this phase, the plants have optimally adapted to the conditions of the aquaponic system, including the availability of dissolved oxygen, pH stability, and nutrient concentrations resulting from the decomposition of abluion wastewater. This adaptation allows the plants to utilize nutrients, especially nitrogen and phosphorus, for the formation of vegetative biomass such as leaves and stems.



**Figure 3.** Crop growth rate of hydroponic water spinach at different plant ages

This increased growth in the middle phase is also related to the microbial nitrification process, in which *Nitrosomonas* and *Nitrobacter* bacteria convert ammonia excreted by fish into nitrate, which can be absorbed by plants. Nitrate is the primary form of nitrogen that plays a vital role in the vegetative growth of kale plants (Alam et al., 2022). Similar results were found by (Andriani et al., 2020) who reported that water spinach plants grown in an aquaponic system with Patin fish showed significant growth increases in the second to third week of the growing season, along with stable nitrate and phosphate levels in the water.

In the following period (21–28 DAP), the CGR value decreased to 1.57 g/day, and further decreased at 28–35 DAP to 0.86 g/day. This decrease can be caused by several factors, including increased competition between plants for nutrients, decreased nutrient concentrations, especially nitrogen ( $\text{NO}_3^-$ ) and phosphate ( $\text{PO}_4^{3-}$ ), and a shift in the plant's physiological phase from vegetative to early reproductive. This condition causes a decrease in photosynthetic efficiency and a shift in energy allocation from leaf formation to flower formation (Azizah et al., 2021).

Physiologically, optimal growth of water spinach plants in the middle phase (14–21 DAP) indicates a balance between the supply of nutrients from the decomposition of abluion wastewater and the biological activity of microbes in the aquaponic system (Afiatun et al., 2022) shows that the use of recycled abluion

water in productive activities in mosque or Islamic boarding school areas can increase environmental awareness and support the concept of a green campus or green Islamic boarding school.

## CONCLUSION

The research results showed that tilapia demonstrated the highest performance compared to other fish species. This was demonstrated by the highest DWG value of 1.43 g/day at 7–14 DAS. The Specific Growth Rate (SGR) of tilapia again showed the highest value at 21% at 7–14 DAS, followed by catfish at 12%.

The growth rate of water spinach plants showed the highest increase in the period 14–21 DAP with a CGR of 2.14 g/day, before decreasing to 1.57 g/day at 21–28 DAP and 0.86 g/day at 28–35 DAP. This optimal growth phase indicates that the plants have adapted well to the aquaponic system and are able to utilize nutrients from the decomposition of fish waste and ablution water waste.

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