

Optimization of Water Spinach Growth (*Ipomoea aquatica*) in The Budikdamber System as A Solution for Eco-Friendly Catfish Cultivation (*Clarias* sp.) in Central Tapanuli Regency

Optimasi Pertumbuhan Kangkung (*Ipomoea aquatica*) pada Sistem Budikdamber sebagai Solusi Budidaya Ikan Lele (*Clarias* sp.) Ramah Lingkungan di Kabupaten Tapanuli Tengah

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ABSTRACT

This study aims to evaluate the effectiveness of an innovative filtration system in bucket aquaponics “budikdamber” on the growth performance of water spinach (*Ipomoea reptans*) at three different locations: Tapan Nauli, STPK Matauli, and the Central Bureau of Statistics of Central Tapanuli (BPS). The experimental design was a randomized block design with two treatments (conventional and innovative filtration systems) and three replications. Observed parameters included plant height, number of leaves, and daily growth rate. The results showed that using the innovative filtration system significantly enhanced plant growth compared to the conventional system. The innovative system recorded the highest plant height at Tapan Nauli, reaching 26.3 ± 1.7 cm and 11.5 ± 0.9 leaves per plant, with a daily growth rate of 3.62%. The innovative filtration system improved water quality through mechanical and biological filters that supported the conversion of ammonia into plant-available nitrate. Thus, this system can be an adaptive and sustainable technology to enhance budikdamber productivity, particularly in coastal and rural areas.

Keywords: budikdamber, innovative filtration, water spinach, plant growth, water quality

ABSTRAK

Penelitian ini bertujuan untuk mengevaluasi efektivitas sistem filtrasi inovatif pada budikdamber (budidaya ikan dalam ember) terhadap performa pertumbuhan kangkung air (*Ipomoea reptans*) di tiga lokasi berbeda: Tapan Nauli, STPK Matauli, dan Badan Pusat Statistik (BPS) Tapanuli Tengah. Rancangan percobaan yang digunakan adalah Rancangan Acak Kelompok (RAK) dengan dua perlakuan (sistem filtrasi konvensional dan sistem filtrasi inovatif) serta tiga ulangan. Parameter yang diamati meliputi tinggi tanaman, jumlah daun, dan laju pertumbuhan harian. Hasil penelitian menunjukkan bahwa penggunaan sistem filtrasi inovatif secara signifikan meningkatkan pertumbuhan tanaman dibandingkan dengan sistem konvensional. Sistem inovatif mencatat tinggi tanaman tertinggi di Tapan Nauli, yaitu $26,3 \pm 1,7$ cm dan $11,5 \pm 0,9$ helai daun per tanaman, dengan laju pertumbuhan harian 3,62%. Sistem filtrasi inovatif ini meningkatkan kualitas air melalui filter mekanis dan biologis yang mendukung konversi amonia menjadi nitrat yang tersedia bagi tanaman. Dengan demikian, sistem ini dapat menjadi teknologi adaptif dan berkelanjutan untuk meningkatkan produktivitas budikdamber, khususnya di wilayah pesisir dan pedesaan.

Kata Kunci: budikdamber, filtrasi inovatif, kangkung air, pertumbuhan tanaman, kualitas air



INTRODUCTION

The Fish in Bucket Cultivation System “Budikdamber” is an aquaponic innovation that allows the cultivation of fish and plants simultaneously in a limited space. This technology is relevant to be applied in areas with limited land, such as coastal areas, including Central Tapanuli Regency. Budikdamber integrates fish rearing, especially catfish (*Clarias* sp.), with the cultivation of plants such as water spinach (*Ipomoea aquatica*) which acts as a natural biofilter in absorbing metabolite waste from fish (Supriyadi et al., 2020).

The problem faced in the conventional Budikdamber system is the accumulation of ammonia and nitrites which can interfere with fish health and inhibit plant growth (Sulastri et al., 2021). Therefore, the innovation of the recirculation system equipped with mechanical and biological filtering is indispensable to improve water quality and system efficiency.

Several plant that have been utilized in aquaponic systems include water spinach (*Ipomoea aquatica*), mustard green (*Brassica juncea*) (Endut et al., 2016; Enduta et al. 2011), Spinach (*S. oleracea*) (Rajalakshmi & Gunasekaran 2024). and Arrowhead plant (Rajalakshmi & Manoj 2023).

Sari et al., (2019) showed that water spinach has a high phytoremediation ability against nitrogen waste. Multiple studies confirm that water spinach is highly effective at removing various forms of nitrogen (ammonia, nitrite, nitrate) from aquaculture wastewater in aquaponic systems (Endut et al., 2016; Enduta et al. 2011; Pandiangan et al., 2021).

However, few studies have not quantitatively measured water spinach growth in the Budikdamber system equipped with filtering. Thus, this study has a novelty in examining the influence of innovative filtering on water spinach growth parameters in the Budikdamber system in three different locations in Central Tapanuli Regency.

This study aims to analyze water spinach growth (plant height and number of leaves) in the innovative Budikdamber system with filtering as an environmentally friendly catfish cultivation solution.

RESEARCH METHOD

Research Time and Location

This research was carried out from July to September 2024 in three different

locations: Tapan Nauli, the Matauli College of Fisheries and Marine Affairs (STPK), and the Central Statistics Agency (BPS) of Central Tapanuli. The locations were selected based on their similar environmental conditions and the availability of facilities and infrastructure to support a simple aquaponic cultivation system.

Budikdamber System Design

The Budikdamber system used is in the form of a plastic bucket with a capacity of 80 L, filled with water as high as 60 L, and stocked with catfish (size of 5–7 cm), 60 fish per bucket. The stocking density refers to research by Yulianto et al., (2020) which showed optimal survival and growth rates in closed aquaponics systems. The maintenance system is carried out semi-intensively, with commercial feed containing $\geq 30\%$ protein, as much as 3–5% of the biomass per day.

Filtering Stage

Filter Mekanism

The mechanical filter uses a coarse sponge and activated charcoal to filter solid impurities such as feed residues and fish feces. Coarse sponges capture large particles, while activated charcoal helps absorb odors and dissolved organic compounds (Azrina et al., 2022).

Biological Filter

The biological filter consists of bioball media and pumice, which serve as a growing substrate for nitrified bacteria such as Nitrosomonas and Nitrobacter, which convert ammonia (NH_3) to nitrate (NO_3^-) (Effendi, 2003). This biological filter is designed so that water passes through the medium continuously to maintain the stability of water quality parameters.

Vegetable Crops

Water spinach plants (*Ipomoea reptans*) are planted in used plastic cups perforated at the bottom and filled with planting medium in husk charcoal. Each bucket is equipped with 10 planting holes that are evenly placed on the top (Permana et al., 2021).

Observed Parameters

Parameters observed during the study include:

- Plant height (cm)
- Number of leaves per plant (strands)
- Feasibility of growing media (based on visual growth criteria and leaf color)

Plant Growth Analysis

The daily growth rate of the plant is calculated using the following equation:

$$\alpha = \left(\sqrt{\frac{wt}{wo}} - 1 \right) \times 100\%$$

Information:

- α = Daily growth rate of plants (%)
 Wt = Average height of final maintenance plants (cm)
 Wo = Average height of early maintenance plants (cm)
 t = Length of maintenance (days)

at a significance level of 5% using SPSS software version 25.0.

Data Analysis

The observation data were analyzed using one-way analysis of variance (ANOVA) to determine the influence of location and systems (conventional vs. innovative) on plant growth parameters. If there is a noticeable difference, it is followed by further testing of Tukey HSD

RESULTS AND DISCUSSION

This study aims to evaluate the influence of innovative filtering system on budikdamber on the growth of water spinach (*Ipomoea reptans*) in three different locations, namely Tapian Nauli, STPK Matauli, and the Central Statistics Agency (BPS). The observed parameters included plant height, number of leaves per plant, and daily growth rate of plants.

Table 1. Average plant height, leaf count, and daily growth rate of water spinach in the Budikdamber system at three different locations

No.	Location	Filtering System	Plant Height (cm)	Leaf Count (strands)	Daily Growth Rate (%)
1	Tapian Nauli	Conventional	18.5 ± 1.2	7.4 ± 0.6	2.14
2	Tapian Nauli	Innovative	26.3 ± 1.7	11.5 ± 0.9	3.62
3	STPK Matauli	Conventional	17.2 ± 1.1	6.8 ± 0.7	1.98
4	STPK Matauli	Innovative	24.8 ± 1.5	10.9 ± 0.8	3.35
5	BPS	Conventional	16.3 ± 1.4	6.3 ± 0.5	1.89
6	BPS	Innovative	23.7 ± 1.3	10.2 ± 0.6	3.14

Remarks: The data were presented as an average ± standard deviation of 3 repetitions per treatment.

Source: Data Processing

The one-way ANOVA analysis results showed a significant difference ($p < 0.05$) in plant height, leaf count, and daily growth rate between conventional systems and innovative filtering systems across sites. Tukey's test results indicate that innovative filtering systems consistently provide better results than conventional systems.

The increase in plant height and number of leaves in the innovative system is influenced by more stable water quality and low ammonia content, because of the existence of two stages of filtering, namely mechanical filters (coarse sponges and activated charcoal) and biological filters (bioballs and pumice stones) that can support the nitrification process.

Mechanical filters (including sponges and activated carbon) effectively reduce suspended solids and ammonia, supporting fish and plant health. Systems with only mechanical filtration may not match the nutrient removal or plant growth benefits of integrated bio-mechanical or plant-based filtration, but still maintain acceptable water quality for aquaponics (Mohamed et al. 2024; Mahabrur & Zulkarnain 2023; Kamauddin et al. 2019).

Biological filter media allow the growth of nitrifying bacteria such as Nitrosomonas and Nitrobacter, which play a role in converting ammonia into nitrate that is more friendly to plants (Rani et al., 2021).

These results are in line with the research of Susilowati et al. (2020), who reported that the presence of biological filter media in aquaponic systems improves the efficiency of nutrient absorption by plants. In addition, the use of husk charcoal as a planting medium contributes to root aeration and water retention, thereby supporting plant vegetative growth (Sutanto et al., 2019).

Different results between locations can be caused by micro-environmental variables such as lighting, daily temperature, and natural aeration levels. Tapian Nauli, as an open location with high light intensity, allows plants to carry out optimal photosynthesis, which also explains the high daily growth rate in these locations compared to other locations that tend to be more shaded. Variations in these conditions between locations can lead to significant differences in plant development and yield (Mareri et al., 2022). A comparison chart of water spinach plant height, number of

leaves, and daily growth rate of water spinach plants can be seen in the Figure 1.

The increase in plant height, leaf count, and daily growth rate on innovative filtering systems demonstrates the effectiveness of filter technology in improving water quality and nutrient availability in aquaponics systems. More stable water conditions and fewer toxins such as ammonia and nitrite support photosynthesis and better plant metabolism

(Rakocy et al., 2006; Somerville et al., 2014).

Innovative systems are also likely to create a microenvironment cleaner from pathogens and dissolved wastes, which supports root growth and nutrient absorption efficiently (Goddek et al., 2015). These results support the idea that biologically and mechanically layered filtering can improve the performance of aquaponic systems.

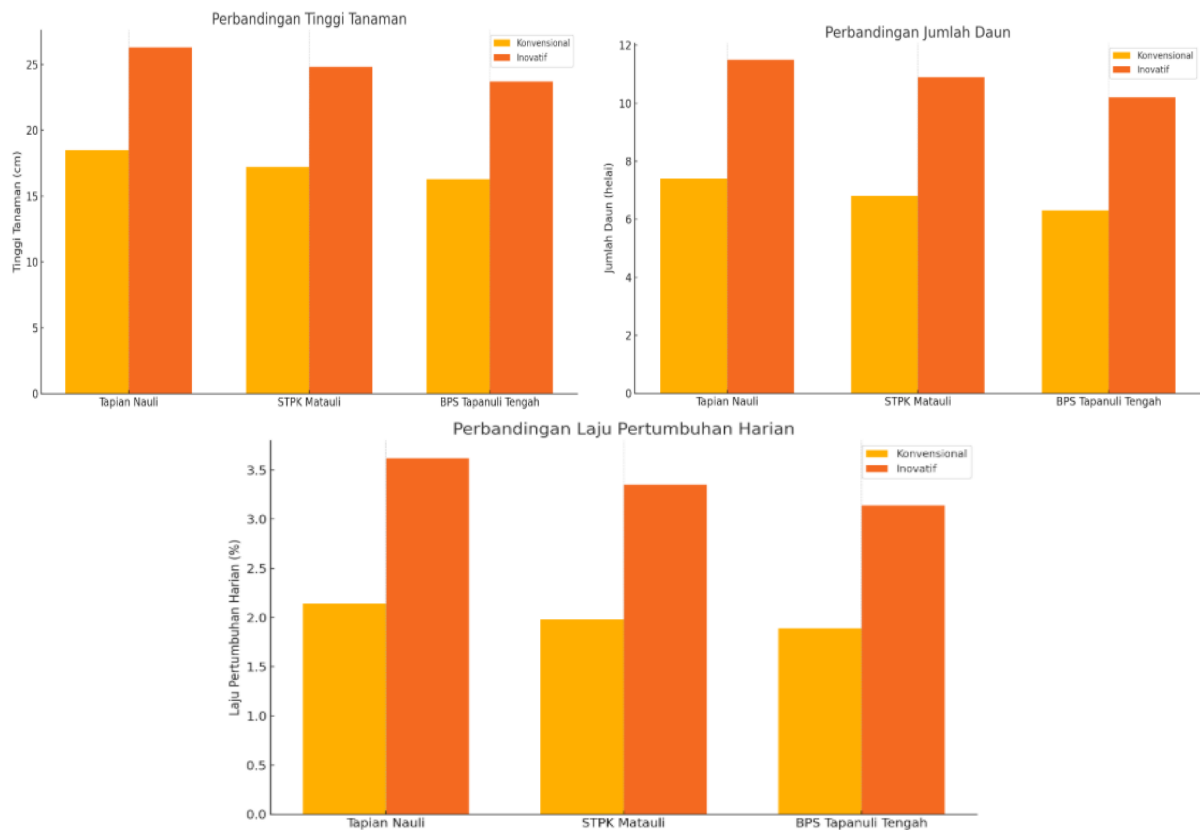


Figure 1. Comparison of plant height, number of leaves, and daily growth rate of water spinach plants

Source: Data Processing

CONCLUSION

Based on the study's results, it can be concluded that the innovative filtering system has a real influence on increasing the growth of water spinach in the "budikdamber" system in various locations. Compared to conventional systems, the innovative system consistently increased plant height, number of leaves, and daily growth rate across all three research sites. The implications of these findings suggest that the application of innovative filtering technology improves the efficiency of nutrient utilization in aquaponics and sustainably increases plant productivity. Thus, innovative filtering systems can be used as appropriate technological solutions in household- and communal-scale aquaponics cultivation, especially in areas with limited land and diverse water quality,

supporting food security programs and coastal community empowerment.

RECOMMENDATIONS

Further research is needed on the efficiency of nutrients (N and P) in the innovative Budikdamber system and its potential integration with other types of crops, such as mustard greens and lettuce. An economic study to determine the financial feasibility of this system on a household scale is also necessary.

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