

Pangasius Aquaponics: A Science-Based Path to Sustainable Food Production

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Aquaponics integrates aquaculture with hydroponics to create a sustainable method of food production, especially when employing hardy species like the striped catfish (*Pangasianodon hypophthalmus*). Current studies have demonstrated that optimizing vital variables like the ratio of fish to plants, dissolved oxygen utilizing Fine Bubble (FB) technology, and iron supplementation can lead to a substantial increase in both fish growth and plant productivity. The most effective biofilter among the tested crops was water spinach, while a practical gravel media system in Punjab demonstrated financial viability with a benefit-cost ratio of 1.33. Integrating these findings suggests sustainable and adaptable aquaponics with pangasius to solve issues related to water conservation, urban agriculture, and food security.

Keywords: Pangasius aquaponics, Fine bubble oxygenation, Iron supplementation, Water spinach biofilter

Introduction

The worldwide food system has to adapt to satisfy rising demand with fewer resources as cities get bigger and agricultural area shrinks. One possible way is aquaponics, a contemporary agricultural technique utilizing fish to care for plants and plants to cleanse water for fish thereby establishing a self-sustaining, closed-loop ecosystem. In this arrangement, hydroponics, the soil-less growth of plants, is coupled with aquaculture, the farming of fish, and organic microbial processes are used to turn fish waste into vital plant nutrients. Farooq et al. (2023) contend that because it consumes space and water very effectively, aquaponics is especially appropriate for urban or land-constrained settings. Simultaneously, it promotes the rise of high-protein fish and nutrient-dense veggies and reduces our reliance on chemical inputs. Many successful systems begin with the striped catfish, a strong and fast-growing species perfectly suited for sustainable food production known as *Pangasianodon hypophthalmus*.

The Role of Pangasius in Driving Aquaponic Efficiency

Pangasianodon hypophthalmus, commonly known as striped catfish, is quickly becoming a preferred species in aquaponic systems. Its omnivorous diet, rapid growth, low tolerance to low dissolved oxygen, and adaptability make it a great choice (Farooq et al., 2023). Among the plants the species has demonstrated compatibility with are spinach, water spinach, lettuce, and pak choi (Andriani et al., 2019; Naomi et al., 2020; Daudi, 2020; Andriani et al., 2020).

Science-Driven Innovations in Pangasius Aquaponics

Iron Supplementation Boosts Growth: Adding iron to aquaponic water is one important breakthrough. Although it is frequently missing in circulating systems, iron is necessary for fish oxygen transport and plant chlorophyll creation. In a 2023 Farooq et al. study, adding 1.5

mg/L of iron (as Fe-EDDHA) every 15 days produced the highest spinach yield (881.74 g/unit) and the biggest fish weight gain (16.34 g). Control systems without iron supplementation displayed markedly reduced results: only 563.67 g spinach yield and 11.72 g fish weight.

Fine Bubbles (FBs) Enhance Oxygenation and Fish Health: Oxygen is critical for both fish survival and microbial nitrification. Fine Bubbles (FBs), minute bubbles under high pressure, were added into the aquaponics system by Naomi et al. in 2020. FBs enhanced dissolved oxygen at 5.5 atm, which caused striped catfish to grow at 6.68%/day and had a survival rate of 100%. The related water spinach also grew very well. Similarly, aquaponic systems with FBs could support stocking densities of up to 600 fish per 150 L without damaging fish health or water quality, according to Bahtiar et al. (2021).

Optimizing Stocking Density: The 50:10 Ratio: It's very important to strike the right balance between plants and fish. Too many fish contaminate the water; too few result in nutrient-lacking plants. Using pangasius and pak choi, Daudi (2020) assessed six stocking densities in a media-bed aquaponic system. At a ratio of 50 fish to ten plants, the best outcomes were observed. High specific growth rates (2.45 - 2.65%/day), over 800% weight gain, and good nutrient reduction performance (for instance, nitrate decreased by 28.7%) define this treatment.

Which Plants Thrive Best with Pangasius: Water spinach (*Ipomoea aquatica*), a leafy vegetable, outperformed lettuce and scallions as a biofilter. Andriani et al. (2019) found the greatest fish growth and survival (93.1%) in aquaponic systems utilizing water spinach. With lower ammonia and nitrate values, water quality greatly improved. Andriani et al. (2020) compared lettuce and water spinach in silver catfish (*Pangasius* sp) aquaponics in more studies. With 38.7 cm stem length, 16 leaves per plant, and 100 percent fish survival, the water spinach system demonstrated its great biofiltration efficiency.

Aquaponics in Practice: A Chemical-Free Model in Punjab

According to Datta and Kaur (2022), a recirculating gravel-based aquaponic system with *Pangasius sutchi* in Punjab, India, was effectively implemented. This greenhouse arrangement had four cement tanks - stocked with 5,000 pangasius fingerlings each - and nine vegetable beds filled with expanded clay aggregates but no artificial pesticides or fertilizers. Over time, the system proved its economic viability as it generated a benefit-cost ratio (BCR) of 1.33 beginning in the second year, therefore highlighting how sustainable aquaponics may be both lucrative and ecologically friendly.

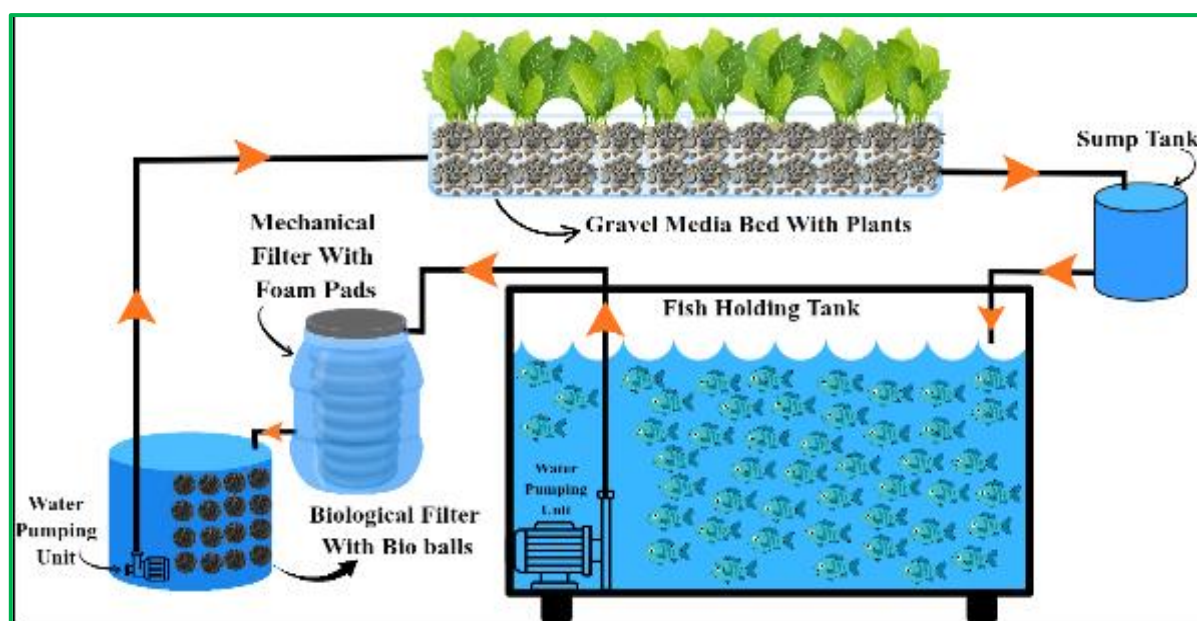


Figure 1: Diagram of Aquaponics Model

Summary of Key Performance Indicators Reported in Aquaponics Research

Metric	Best Result	Source
Optimal iron dose	1.5 mg/L	Farooq et al. (2023)
Highest spinach yield	881.74 g/unit	Farooq et al. (2023)
Maximum fish growth rate (SGR)	6.68%/day	Naomi et al. (2020)
Ideal fish:plant ratio	50:10	Daudi (2020)
Survival rate at high density	100% (600 fish/150 L)	Bahtiar et al. (2021)
Best plant for biofiltration	Water spinach	Andriani et al. (2019; 2020)
Profitability indicator (BCR)	1.33	Datta and Kaur (2022)

Challenges and Future Possibilities

Despite its promise, aquaponics is not without challenges:

- High initial capital investment.
- Need for technical expertise in water chemistry and system design.
- Limited market awareness for aquaponic produce.

However, the future looks promising. Potential developments include:

- Automation with IoT for real-time monitoring.
- Urban rooftop aquaponics to reduce food miles.
- Integration into school and community nutrition programs.

Conclusion

Aquaponics, especially when cantered around species like pangasius and crops like water spinach, is a significant advancement in sustainable food production. It is a water-saving, chemical-free agricultural system that works well in both urban and rural environments. According to study by Farooq et al. (2023), Daudi (2020), Naomi et al. (2020), and others, pangasius aquaponics is not simply a notion; it is a practical reality that may feed cities, support communities, and cure the environment.

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