

POTENTIAL OF ORNAMENTAL FISH CULTIVATION IN AQUAPONIC SYSTEMS (LITERATURE REVIEW)

Potensi Budidaya Ikan Hias Dalam Sistem Akuaponik (*Literature Review*)

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ABSTRACT

Indonesia ornamental fish industry is experiencing increasing popularity, demonstrated by a 1.99% rise in production in the first quarter of 2024 compared to the first quarter of 2023. The intensive fish farming system is a method that applies high density and provides artificial feed that has high protein to support optimal fish growth. Aquaponics is a cultivation system that can save water usage by up to 97% compared to conventional methods. This system also maintains water quality through synergistic interactions between fish and plants, creating a more productive environment. The purpose of this study was to determine the potential of various ornamental fish that can be cultivated in the aquaponic system. Based on the results obtained regarding ornamental fish cultivated in the aquaponic system, there are several types of ornamental fish that have been cultivated such as goldfish, koi fish and comet fish. The aquaponic system can also increase the growth value of length and weight, daily growth rate and survival rate of ornamental fish by 90% - 100%.

Keywords: cultivation, ornamental fish, aquaponic system, growth

ABSTRAK

Industri ikan hias Indonesia mengalami peningkatan popularitas yang ditunjukkan dengan kenaikan produksi sebesar 1,99% pada triwulan I tahun 2024 dibandingkan triwulan I tahun 2023. Sistem budidaya ikan secara intensif merupakan metode yang menerapkan kepadatan tinggi serta pemberian pakan buatan yang memiliki protein tinggi untuk mendukung pertumbuhan ikan secara optimal. Akuaponik adalah sistem budidaya yang mampu menghemat penggunaan air hingga 97% dibanding metode konvensional. Sistem ini juga mempertahankan kualitas air melalui interaksi sinergis antara ikan dan tanaman, menciptakan lingkungan yang lebih produktif. Tujuan dari penelitian ini adalah untuk mengetahui potensi berbagai ikan hias yang dapat dibudidayakan pada sistem akuaponik. Berdasarkan hasil yang didapatkan mengenai ikan hias yang dibudidayakan dalam sistem akuaponik terdapat beberapa jenis ikan hias yang telah dibudidayakan seperti ikan mas koki, ikan koi dan ikan komet. Sistem akuaponik juga dapat meningkatkan nilai pertumbuhan panjang dan bobot, laju pertumbuhan harian dan tingkat kelangsungan hidup ikan hias dengan nilai sebesar 90% - 100%.

Kata Kunci: budidaya, ikan hias, pertumbuhan, sistem akuaponik

INTRODUCTION

Indonesian waters are rich in ornamental fish diversity, including 240 species of marine ornamental fish and 226 species of freshwater ornamental fish (Khoironi & Saskara 2017). Overall, Indonesia has 1,154 species of ornamental fish, most of which are freshwater fish (Kusumah & Parsetio 2017). The Indonesian ornamental fish industry is experiencing an increase in popularity as indicated by a 1.99% increase in production in the first quarter of 2024 compared to the first quarter of 2023 (DJPB, 2024). With increasing demand, efforts are needed to achieve the ornamental fish production target, in the form of intensive and sustainable cultivation.

The intensive fish cultivation system is a method developed by implementing high density and providing artificial feed that has a high protein content to support optimal fish growth (Martudi *et al.*, 2017). This method has the advantage of more efficient production costs. However, high density can reduce water quality, which leads to increased waste such as ammonia (Afriansyah *et al.*, 2016). Inefficient use of water resources has limited further development of the aquaculture sector. One effort to reduce waste from cultivation and increase fish production is to implement an aquaponic cultivation system.

Aquaponics is a system that can save water usage up to 97% compared to conventional methods. This system also maintains water quality through synergistic interactions between fish and plants, creating a more productive environment (Zidni *et al.*, 2013). Waste produced by fish will be nitrified by bacteria and will function as fertilizer for plants, which will absorb the nitrate content in the water. Aquaponics produces quality water that meets fish cultivation standards (Dauhan *et al.*, 2014). Selecting the right commodities in aquaponics can realize a sustainable and environmentally friendly production model. This study aims to identify the potential of various types of ornamental fish that are suitable for cultivation in the aquaponic system.

RESEARCH METHODS

The method used is literature study. Literature study is a method of collecting data by searching for written sources such as books or literature to understand the relevant theoretical basis (Rusmawan, 2019). This journal uses data sourced from 48 references covering various literature and previous research related to ornamental fish cultivation carried out in an aquaponic system that is relevant to the keywords ornamental fish, cultivation, and aquaponics from various sources such as: Google Scholar, Elsevier, Springer and Research Gate.

RESULT

Aquaponics System

Aquaponics is an integrated system that combines aquaculture and hydroponics in a symbiotic relationship. Plants act as biofilters, cleaning the water before returning it to the fish pond. So that the plants used can support the growth and survival of the fish being farmed. Although plants function to absorb ammonia in aquaponics, their effectiveness can decrease as the ammonia concentration increases. Uneaten high-protein feed and fish feces are the main causes of increased ammonia in cultivation ponds (Zidni *et al.*, 2019). Aquaponics is based on saving land and water, as well as increasing production efficiency by recycling nutrients from remaining feed and fish metabolism for plants. This cultivation system is also known as an environmentally friendly method (Zidni *et al.*, 2013).

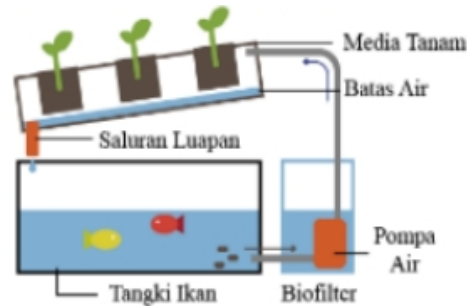


Figure 1. Aquaponics System
(Source: Assafah & Primaditya 2020)

The aquaponic system has several advantages such as water efficiency of up to 90% compared to conventional cultivation methods, able to reduce the use of chemicals and pesticides because plants get nutrients directly from water that carries fish waste. According to Rakocy *et al.*, (2006) showed that aquaponics supports faster plant growth than conventional soil systems, because plants receive nutrients directly from nutrient-rich water. In addition, plants tend to be more resistant to pests and diseases because the environment is more controlled. Aquaponics can be applied in limited land such as urban areas, areas with barren land, or small islands (Hamdani *et al.*, 2022).

Types of Ornamental Fish in Aquaponic Systems



Figure 2. Types of Ornamental Fish

Koi Fish

Koi fish are one type of ornamental fish that has been widely cultivated by the community. Koi fish were first developed in Japan which has the name Nishikigoi. The types of koi fish are also very diverse, including Kohaku, Showa, Sanke, and Shiro. Koi fish have patterns and colors of red, white, yellow, black, or a combination of these colors located on the back (Alim & Muahiddah 2023). The uniqueness of koi fish comes from the color of the scales and the varying color patterns. Koi have gone through a lot of selective breeding to produce more than 100 color variations (Tamadachi, 1990). Some of the popular variations include kohaku, sanke and showa.

Goldfish

Goldfish (*Carassius auratus*) is a fish domesticated from crucian carp. This fish is a freshwater ornamental fish that is in great demand because the uniqueness of goldfish comes from its body, color, fins and eyes that vary (Komiya *et al.*, 2009). Some popular types of goldfish are Oranda, Ranchu and Ryukin. Cultivating this fish does not require a large area of

land, because it can be kept in various containers such as aquariums, concrete pools, fiber tubs or pools with other models.

Comet Fish

Comet fish are fish that come from China and have beautiful colors, and unique body shapes, comet fish are one of the most popular ornamental fish. The color variations, such as white, yellow, red, or a combination of them, increase their selling value so that many people try to make a profit. In the cultivation of comet fish, it does not require a large area, but requires skills and cultivation techniques that are continuously improved (Lapadi *et al.*, 2017).

Guppy Fish

Guppy fish (*Poecilia reticulata*) is a small ornamental fish (<2.5 cm) from South America (Reznick & Travis 2019) that has high commercial value in domestic and international markets. This fish is in great demand because it has attractive color variations and unique tail shapes, such as fans, round, or wide. Male guppies have very attractive tail fins because of their width and various patterns (Pratama *et al.*, 2018). Guppy fish color variations include red, blue, yellow, green, black, white, or other colors, with tail patterns such as spear tail, pin tail, veil tail, round tail, and fan tail (Vasantharajan 2023).

Botia Fish

Botia fish are ornamental fish originating from the Sumatra and Kalimantan regions which have high economic value. Because its production depends on natural catches, its supply is not always sustainable. According to Puluhulawa *et al.*, (2021), botia fish are easier to find when the river water is high or during the rainy season (October–March). Botia has an attractive color combination, namely a reddish dark yellow base color combined with three grayish black vertical lines (Dahrudin 2011).

Sumatra Fish

The Sumatran fish (*Puntius tetrazona*) is a popular ornamental fish from Sumatra and Kalimantan that is widely favored (Harlena 2021). Its popularity is supported by its bright colors, agile movements, group behavior, and ease of maintenance. The characteristic of the Sumatran fish is the four striking black and orange bands on its body (Wijianto *et al.*, 2019). The quality of the Sumatran fish is determined by the type, color, size, and shape of its body (Nafsihi *et al.*, 2016).

Supporting Factors in Ornamental Fish Cultivation

Genetics

Ornamental fish that exist today are the result of the development of preferred traits, such as size, color, color patterns, and body shape. In order for fish to express targeted traits, spawning efforts such as hybridization, crossbreeding, selective breeding and others can be carried out (Zhou & Gui 2018). Or with tools that can edit target genes, such as the CRISPR-Cas9 system (Palmiotti *et al.*, 2023)

Feed

Fish growth rate is highly dependent on the type and quality of feed. Good quality feed and sufficient quantity will accelerate growth, while poor quality feed and insufficient quantity will inhibit growth (Yanuar 2017). The quality of feed in fish farming affects the growth and color of fish. Feed contains protein that is essential for growth, and the right protein levels are essential for the growth and weight gain of fish. Since aquatic animals cannot produce their own carotenoid pigments, the addition of feed containing these pigments is necessary to enhance color. (Mardiana *et al.*, 2022).

Water Quality

Water quality greatly affects the growth of ornamental fish. In aquaculture systems such as aquaponics, bacteria play an important role in reducing or eliminating ammonia through the nitrification process (Dauhan *et al.*, 2014). Bacteria such as *Bacillus* and *Pseudomonas putida* are effective in decomposing organic matter, maintaining stable water quality. Dissolved oxygen (DO) is an important parameter that affects fish and nitrifying bacteria.

Ornamental Fish Cultivation in Aquaponic System

The aquaponic system is a combination of fish farming systems with hydroponics. Where fish need stable water quality to support growth and plants that need nutrients to support growth. The nutrients needed by plants come from the results of nitrification from bacteria and also feed (Luo *et al.*, 2020). And the results of nutrient absorption will produce good water quality (Somerville *et al.*, 2014). Optimal water quality can support fish farming, including ornamental fish. Where the aquaponic system can increase the growth of ornamental fish. The following are some of the results of research on ornamental fish that have been carried out in the aquaponic system (Table 1).

Table 1. Research on ornamental fish in aquaponic systems

No	Types of Ornamental Fish	Results	References
1	Goldfish	Goldfish <i>C. auratus</i> maintained in an aquaponic system with water jasmine plants showed significantly different results. The survival rate of goldfish during the study ranged from 95% - 100%, with a length growth of 4.97 ± 0.02 cm, and a weight of 5.21 ± 0.10 g.	(Kandarini <i>et al.</i> 2021)
2	<i>Carassius auratus</i>	The results showed that the specific daily growth rate of FBs in an aquaponic system with a pressure of 5.75 atm was 2.51%, absolute length growth was 3.33%, absolute weight growth was 1.70 g and the fish survival rate was 99.3%.	(Andriani <i>et al.</i> 2023)
3	Comet Fish	The survival rate (SR) of koi fish in the aquaponic system reached 100% with a density of 5 and 15 plants. Meanwhile, the lowest survival rate in koi fish cultivation was 86%, with a density of 10 and 15 plants.	(Pratiwi <i>et al.</i> 2022)
4	<i>Carassius auratus</i>	The best increase was 258 g with a specific growth rate ranging from 0.19 to 0.56 and an SR value of more than 90%.	(Urrestarazu <i>et al.</i> 2019)
5	Koi Fish	This study produced the highest weight growth of 7.13 ± 0.046 and a length of 8.64 ± 0.116 with a daily growth rate of 0.94 ± 0.009 and 100% survival.	(Nuwansi <i>et al.</i> 2019)

DISCUSSION

Supporting Factors in Ornamental Fish Cultivation

Carotenoids are pigments that can produce colors such as yellow, red and orange (Das & Biswas 2016). Carotenoids are also essential nutrients for the growth, reproduction and health of fish. Carotenoids can be obtained synthetically (astaxanthin, cantaxanthin etc.) or extracted naturally. The use of synthetic carotenoids such as astaxanthin to enhance the color of ornamental fish, such as *Amphiprion ocellaris* (Yulianti *et al.*, 2014), *Carrasius auratus* (Phonna *et al.*, 2022), *Xiphophorus helleri* (Rachmawati *et al.*, 2016). The use of carotenoids from natural ingredients has also been widely used and is able to increase the brightness of fish colors, examples of natural ingredients can be from red peppers (Putriana *et al.*, 2015), carrots (Budi & Mardiana 2021), pumpkin (Sartikawati *et al.*, 2020), and shrimp (Riansah *et al.*, 2020).

According to Zidni *et al.*, (2013) stated that dissolved oxygen in the maintenance media has an important role in the oxidation and reduction process of organic and inorganic materials with the help of nitrifying bacteria, which can reduce pollution in fish farming. Low oxygen levels cause competition between fish and bacteria that decompose organic materials to obtain oxygen. Temperature is also an important parameter for aquatic animals; fish growth slows below 20°C and increases the risk of disease. Optimal temperature supports the activity of Nitrobacter and Nitrosomonas bacteria, which increase plant productivity (Zidni *et al.*, 2019).

Ornamental Fish Cultivation in Aquaponic System

Optimal water quality in an aquaponic system increases the growth of ornamental fish compared to non-aquaponic systems. Cultivating fish and plants in aquaponics can increase the concentration of dissolved oxygen, which is important for living organisms to breathe, metabolize, grow, and decompose organic matter (Setiyaningsih *et al.*, 2020). Increasing the concentration of dissolved oxygen can stimulate fish appetite, so that the fish being raised grow faster (Nugroho *et al.*, 2013).

The aquaponic system is a cultivation system that can reduce the concentration of nitrogen contained in the water in the fish maintenance container because of the biofilter in the form of plants, water containing nitrogen in the fish maintenance container is flowed to the plants, then used as nutrients (Hasan *et al.*, 2017). Water containing nitrogen in the fish maintenance container will be oxidized through the nitrification process. Nitrification is the process of removing inorganic nitrogen that can occur optimally if the dissolved oxygen requirement in the fish maintenance container is met (Naomi *et al.*, 2020). The decline in water quality can also be caused by fish metabolic waste containing ammonia (Shobibah *et al.*, 2022). The aquaponic system can reduce ammonia by absorbing wastewater from cultivation or wastewater through plant roots. The absorbed ammonia then undergoes oxidation with the help of oxygen and bacteria (Widyastuti 2008).

CONCLUSION

Based on the results obtained from various literature on ornamental fish cultivated in the aquaponic system, there are several types of ornamental fish that have been cultivated such as goldfish, koi fish and comet fish. The aquaponic system can also increase the growth value of length and weight, daily growth rate and survival rate of ornamental fish with a value of 90% - 100%.

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