Analysis of Water Quality in Layer Cage with Aquaponic System in PLTA Koto Panjang Container, Kampar District

E Sumiarsh*  
1Faculty of Fisheries and Marine Science, Universitas Riau, Indonesia  
*Corresponding Author e-mail: eni.sumiarsh@lecturer.unri.ac.id

Abstract. Aquaponics is one way to reduce water pollution produced by fish farming, it can also be an alternative to reduce the amount of water used in the aquaculture system. Water quality is an important factor in fish farming activities because it can affect the growth and development of fish cultivated in reservoir waters. The purpose of this study was to analyze the water quality of the KJA (floating net cages) layered with the aquaponic system tested in the waters of the Koto Panjang Hydroelectric Reservoir. This research was conducted in June - August 2020 at the Koto Panjang Hydroelectric Reservoir. Measurement of water quality parameters is carried out directly at the research location. The analysis of the physical and chemical parameters of the waters is measured in the laboratory and the calculation of the water quality parameters refers to the APHA-AWWA and is compared with Government Regulation Number 82 of 2001 concerning Class II water quality standards. Based on the results of observations on water quality in layered cages with the aquaponics system, it is known that temperature parameters range from 31-33ºC, pH ranges from 5-6, dissolved oxygen ranges from 9.38 - 9.65 mg / L, free carbon dioxide ranges from 9.14 - 11, 12 mg / L and brightness range from 148.9 to 156.2 cm. Meanwhile, nitrate parameters ranged from 0.03-0.04 mg / L and phosphates ranged from 0.30 to 0.06 mg / L. The water quality in the layered marine cage in the aquaponics system in the Koto Panjang Hydroelectric Reservoir has been able to reduce nitrate and phosphate content so that it can reduce the impact of organic pollution that occurs in the waters of the Koto Panjang Hydroelectric Reservoir.

1. Introduction
The waters of Koto Panjang Hydroelectric Reservoir is one of the reservoirs used as a large floating net cage fish cultivation area in Riau Province. With the increasing number of the waters cage in the waters of the Koto Panjang hydropower reservoir, it is suspected that later it will have negative impacts, such as a decrease in the quality of the waters of the Koto Panjang Hydroelectric Reservoir. As a culture system, the KJA system has begun to be developed economically in the Koto Panjang Reservoir since 2001, until now it uses artificial feed as a source of feed for the fish raised in the KJA. Not all of the feed given can be eaten by the fish in the cage. The rest of the feed in the KJA, which is not eaten by fish, and the metabolic waste in the form of fish feces and urine are waste from the KJA activities. Naturally, this food residue and metabolic waste will fall and sediment at the bottom of the water. The remaining feed wasted and not eaten by cultured fish can reach 19.28% [1]. Furthermore, according to [2, 3] The presence of marine cage in the waters can reduce water quality, due to the input of organic material in the form of fish feed and fish feces into the waters.

Based on the aforementioned problems, there must be innovation in the marine cage system fish cultivation technology which is more environmentally friendly, saves water, and can increase fish production. One form of innovation is integrating aquaculture with plants through an aquaponics system [4]. Aquaponics is one of the cultivation technologies that combines fish farming with plants [5]. This system can save water use in fish farming up to 97% [6]. Aquaponics is the concept of developing a bio-integrated farming system, which is a series of technologies that combine fishery and agricultural cultivation techniques. This
aquaponics technology is designed to utilize water containing leftover feed and feces from fish as a source of plant nutrition or in other words a recirculating aquaculture system [7, 8, 9]. The aquaponics system is able to reduce ammonia by absorbing water from fish farming activities by plant roots [10]. Almost all types of aquatic plants and some land plants can be used in aquaponics systems including water kale (*Ipomoea Aquatica* Forsk), land kale (*Ipomoea reptans* Poir), and lettuce (*Lactuca sativa*). This plant as an alternative to biofilter can absorb nitrogen in the form of ammonium (NH4 +) and nitrate (NO3 -) so that nitrogen in the water will decrease [11]. Water quality is an important factor in aquaculture and aquaponics is one of the solutions in maintaining water quality in cultivation media. The purpose of this study was to analyze the quality of the water around the layered marine cage with an aquaponic system in the waters of the Koto Panjang reservoir in the Kampar Regency.

2. Methodology
This research was conducted at Koto Panjang Hydroelectric Reservoir in June-August 2020. The data used in this study are primary and secondary data. Primary data collection was carried out by the survey method. Primary data used is the result of water quality that is observed every week. Water quality data obtained from waters cage with aquaponics system and water quality measurement around KJA in the DAM area. In this study, three stations were assigned to measure water quality. Station 1 is around the Aquaponics KJA, Station 2 is at a distance of 200 M from station 1, where there are many KJA with more than 500 plot holes, and on the side of the lake, there are many plantation plants belonging to the local community. Station 3 is in the DAM area, and many KJA are placed with a total of 700 mapped holes. This station is also close to the outlet area of the Koto Panjang PLTA Reservoir.

2.1 Calculation of the growth of water spinach maintained by the aquaponic system
The parameters measured were water spinach weight growth, while the plant parameters included biomass, increase in stem length, and increase in the number of leaves. Weight gain and plant growth are calculated using the following equation [12]:

\[ PM = W_t - W_0 \]

Information:
PM = growth
W0 = initial weight
Wt = final weight

Secondary data were obtained from various research reports and research journals. Furthermore, primary and secondary data were tabulated and analyzed descriptively.

3. Results and Discussion
3.1. Koto Panjang Hydroelectric Reservoir
Koto Panjang Reservoir is a reservoir located in XIII Koto Kampar District, Kampar Regency, Riau Province. Reservoir with an area of 12,400 ha. This area is a reservoir with multiple functions, including a hydroelectric power plant (PLTA), irrigation, tourism, and aquaculture in the form of ponds. In the fisheries sector, Koto Panjang Reservoir is a source of income for local fishermen. The catch was dominated by paweh (*Osteochilus haseltii*) (35.2%), motan (*Thynnichthy polylepis*) (28.2%), and siban (*Cyclocheilicthys apogon*) (14.8%). Several types of economically important fish include baung (*Hemibragus nemurus*), tapah (*Wallago sp.*), Belida (*Chitala lopis*), tabingalan (*Puntioplites Bulu*), toman (*Channa micropeltes*), carp (*Osphronemus goramy*) with a potential production of hundreds of tons each month.

The Koto Panjang Hydroelectric Reservoir has an area boundary, bordering a portion of community-owned land which has been managed since before the reservoir was built until this reservoir is completed. Another part of this reservoir is directly adjacent to the forest area. After the construction of this reservoir is complete, the area of land managed by the
community in the catchment area for agriculture and plantations continues to increase, while the waters of the reservoir itself are used by the community for KJA fisheries. Most of the floating marine cages in the Koto Hydroelectric Reservoir are concentrated around the DAM. The number of KJA operating in the Koto Panjang Hydroelectric Reservoir continues to increase every year. The number of floating marine cage in 2006 was 513 plots, but in 2009 the number of waters cage was 900 plots, in 2014 the number of the floating cage was 1,200 plots and in 2016 the number of waters cage was 1,288 plots.

3.2. Water Quality with Aquaponics System

Water quality is an important factor in fish farming activities because it can affect the growth and development of cultivated fish in reservoir waters. Fish development will encourage and support fish growth properly. However, if the water quality is poor, such as due to organic and inorganic pollution, this will affect the growth and development of cultivated fish, such as in the case of slow growth and disturbing fish health due to disease attacks.

Based on the results of measurements of the water quality of the Koto Panjang hydropower reservoir during the study, it fluctuates. This is due to differences in conditions at the time of sampling (Table 1). Temperature parameters during the study ranged from 31-33°C, pH ranged from 5-6, dissolved oxygen ranged from 9.38 to 9.65 mg / L, free carbon dioxide ranged from 9.14 - 11.12 mg / L and brightness during the study ranged from 148, 9 - 156, 2 cm. Meanwhile, nitrate parameters ranged from 0.03-0.04 mg / L and phosphates ranged from 0.30 to 0.06 mg / L.

| Parameter       | Value Range | Station 1 | Station 2 | Station 3 |
|-----------------|-------------|-----------|-----------|-----------|
| A. Physics      |             |           |           |           |
| Temperature     | °C          | 31 -32    | 31 -33    | 32 - 33   |
| Brightness      | cm          | 148,9     | 169,4     | 156,2     |
| B. Chemistry    |             |           |           |           |
| pH              | 5-6         | 5-6       | 5-6       |           |
| Dissolved Oxygen| mg/L        | 9,52      | 9,65      | 9,38      |
| Free carbon dioxide | mg/L       | 9,14      | 9,52      | 11,12     |
| Nitrate         | mg/L        | 0,044     | 0,034     | 0,045     |
| Phosphate       | mg/L        | 0,193     | 0,058     | 0,063     |

Table 1. Quality of Waters around the Dam Site and Aquaponic System

Temperature is very important physical factor in water quality, because together with the substances/elements contained therein will determine the density of water, and together with pressure can be used to determine the density of water [13]. Temperature is an important factor in fish metabolism and the aquatic environment, such as an increase in temperature can result in a decrease in oxygen solubility [14]. The water temperature during the study tended not to be much different for each observation, which was in the range of 31 - 33°C. Fish can grow well in a temperature range of 25-32 °C, but sudden changes in temperature can cause stress for fish [15].

Not much different from temperature, the pH value in the reservoir waters during the study was in the range of 5 - 6 which was suitable for aquaculture activities. The brightness value in the waters of the Koto Panjang hydropower reservoir around the dam site ranges from 148.9 to 156.2 cm. The high and low brightness values in the Koto Panjang hydropower reservoir are influenced by the presence of particles that can interfere with the entry of sunlight into the water column, then the brightness value at each point of the study location is also influenced by weather conditions and observation time.

Brightness is closely related to primary productivity because it is an important factor in
The rate of photosynthesis where the brightness value is identified with depth as the photosynthesis process takes place. Brightness can be influenced by factors such as watercolor, dissolved substances, and suspended particles [16].

Dissolved oxygen concentrations around the water cages of the Koto Panjang Hydroelectric Reservoir ranged from 9.38 to 9.65 mg / L. Dissolved oxygen content is included in the good category because it does not exceed the quality standard that has been determined. According to [17], dissolved oxygen levels of 5-6 mg / L are considered the most ideal for the growth and development of aquatic organisms. The range of dissolved oxygen that can normally support aquatic organisms should not be less than 2 mg / L. In other words, if seen from the results of measurements of DO values, they are in good condition for the survival of aquatic organisms.

The free carbon dioxide concentration during research in the waters was still in a good category for aquatic organisms with a range of 9.14 - 11.12 mg / L. Free carbon dioxide in the water should not be more than 12 mg / L and not less than 2 mg / L. According to [18], the free carbon dioxide level of 10 mg / L can still be tolerated by the original aquatic organisms accompanied by sufficient oxygen levels. Most of the aquatic organisms can survive until the free carbon dioxide level reaches 60 mg / L [19].

The concentrations of nitrate and phosphate around the floating net cages in the Koto Panjang Hydroelectric Reservoir are still considered good for aquatic biota, for nitrates at all observation points are still below 10 mg / L and phosphate is still below 0.2 mg / L. Nitrate levels in the Koto Panjang Hydroelectric Reservoir were also the same in the conditions of the Pandandure Reservoir whose nitrate content was below 10 mg / L based on research [20]. The concentration of nitrogen, both nitrate and nitrite, tends to vary, which is thought to be highly dependent on the presence of nitrifying bacteria. These bacteria play a role in changing the form of ammonium nitrogen, nitrite to nitrate.

Phosphorus is needed in the development and growth of fish bones. If phosphorus deficiency can cause abnormal development, deformed bones, impaired growth, and even fish death, as well as high phosphorus concentration can disrupt the body's metabolic processes [21]. Phosphorus will be used by fish according to their body needs, and phosphorus that cannot be utilized will be excreted in the form of feces and urine [22]. The need for phosphorus for fish is 0.6 - 0.7% for goldfish and 0.8 - 1.0% for tilapia [23]. Deep and more open marine cage systems such as marine cage tend to have fairly high water flow and dispersion of leftover food and fish feces so that some of the leftover feed and fish feces decompose and settle elsewhere [24].

Water quality plays an important role in fisheries, especially for aquaculture and aquatic animal productivity. Water quality parameters that are often observed include temperature, brightness, pH, dissolved oxygen, carbon dioxide, alkalinity, hardness, phosphate, nitrogen, and others [25]. The influence of water quality on cultivation activities is very important so that it is absolutely necessary for cultivators to monitor water quality parameters. The decline in water quality with the aquaponics system in the Koto Panjang hydropower reservoir has not resulted in maximum reduction results because the circulation system and wasted feed waste and fish feces cannot be removed with a pump due to the lack of electricity in the Koto Panjang Hydroelectric Reservoir.

### 3.3. Growth of water spinach

Plant growth is indicated by the increase in size, weight, and the number of leaves. Plant growth is a measurable external form of plants that can also be seen as a result of work or interactions between traits [26]. The results of aquaponics plants are organic products because they do not use chemicals in the form of fertilizers or pesticides in the planting process so that they are expected to have a high selling value. The growth of kale plants, both the increase in stem length and weight, showed a value that was not much different in each KJA plot. KJA 1 growth ranged from 16-25 cm, KJA 2 growth ranged from 19-26 cm, in KJA 3 growth ranged from 17-27 cm and KJA 4 ranged from 17-20 cm. Meanwhile, weight growth in KJA 1 ranged from 8 to 16 gr, for KJA 2 it was around 9 - 19 gr, for KJA 3 it was around 8 - 17 gr, and for KJA 4 the weight of water spinach was around 8 - 17 gr.
The growth of water plants (Kangkung) in aquaponics in the first week of growth is faster, while for the third week the growth of kale is slow. This is due to the hot conditions while the good temperature for the life of kale is 20-28 °C while during the research the temperature in the Koto Panjang hydropower reservoir ranged from 31-33 °C. and the water spinach plant media did not reach the reservoir waters because the reservoir water was receding. Which resulted in poor growth of kale and in the sampling of the three kale plants withered (turned yellow). This is also caused by water spinach plants that do not absorb nutrients properly.

This condition is different from the research of [27] that the growth of kale on biofilter media is very fast compared to the growth of pakcoy, lettuce, and red spinach. Plants that have sufficient leaves will reduce inorganic nitrogen in water more and more into new cells for the plant body, while plants that have few leaves will have little growth, have a dull appearance, or experience death (wither) [27]. Water spinach can grow in areas with hot and cold climates. The amount of rainfall that is good for this plant growth ranges from 500-5000 mm/year, the temperature suitable for kale plants is between 20-28°C. In the rainy season, kale plants grow very fast and are fertile, as long as there are no weeds around [28].

The growth of kale leaves is also small (the number of kale leaves is also small), while the length of the plant and the number of leaves are indicators of nutrient absorption from water used by plants through photosynthesis in the leaves and the results will be seen from the increase in the number of leaves and plant length. Kale plants have a faster initial growth rate. These conditions support kale plants to grow and absorb nutrients quickly. The faster the plants grow, the more inorganic nitrogen will be absorbed and the less toxicity will be in cultivation water [29].

4. Conclusion
Water quality is an important factor in fish farming activities because it can affect the growth and development of cultivated fish in reservoir waters. The water quality of the Koto Panjang hydropower reservoir still supports the life of fish organisms. The growth of water plants (Kangkung) in aquaponics in the first week of growth is faster, while for the third week the growth of kale is slow. The influence of water quality on cultivation activities is very important so that it is absolutely necessary for cultivators to monitor water quality parameters. The decline in water quality with the aquaponics system in the Koto Panjang hydropower reservoir has not resulted in maximum reduction results because the circulation system and wasted feed waste and fish feces cannot be removed with a pump due to the lack of electricity in the Koto Panjang Hydroelectric Reservoir.

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