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Analysis of the water quality of the Wiringtasi River, Barru Regency, Indonesia, in relation to fish cultivation

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Abstract

Objective: This research aims to determine the quality of water along the Wiringtasi River, Barru Regency, Indonesia in relation to the development of fish cultivation.

Material and method: Sampling was carried out by random sampling by selecting three research locations, namely location 1 is a river location close to rice fields, location 2 is a location close to pond areas and beaches, and location 3 is a location around the mouth of the Wiringtasi River. The data collected is water quality parameter data, which includes temperature, dissolved oxygen, pH, and salinity. The data obtained is then processed and linked to fish cultivation needs. The data was then analyzed using descriptive analysis.

Results: The research results show that the water temperature in the Wiringtasi river is in the average range of 29.4–30.4 ^{o}C. The average dissolved oxygen at the research location is in the range of 4.31–5.08 ppm. The average value of water pH at the research location is in the range of 6.33-7.17, while the average value of water salinity at the research location is in the range of 12.67-36.83 ppt.

Conclusion: All water quality parameters measured in the Wiringtasi River, Barru Regency, Indonesia, are still in accordance with the growth and survival needs of fish.

Keywords: Water quality; River; Wiringtation; Cultivation; Fish

1. Introduction

A natural resource, water is necessary for the survival of many species, including humans. Water resources need to be preserved so that people and other living things can continue to use them appropriately; water needs to be used carefully for a variety of uses (Effendi, 2003). One example of water that is still used by a small number of residents is river water. River water is water that flows from upstream to downstream through residential areas (Azizah and Humairoh, 2015). According to Keraf (2010), rivers are widely used for human purposes such as water storage, transportation, irrigating rice fields, livestock purposes, industrial purposes, housing purposes and also as flood control.

Rivers are generally connected directly to the sea through estuaries. Water circulation in estuary areas is greatly influenced by the flow of fresh water originating from river bodies and salt water originating from the sea. The mixing of the two water masses that occurs at the river mouth can cause changes in the physical oceanographic conditions at that location. One of them is the fluctuation of salinity, which together with temperature will affect the circulation of water masses (Robert, 2005 in Hadikusumah, 2008). A river basin is an area bounded by topographical dividers that

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can accommodate, store, and channel rainwater that falls on it into rivers and ultimately empties into lakes or the sea (Nilda, 2014).

A river is an elongated stream of water that flows continuously from upstream to downstream. The upstream is the highest part of the river channel and is the initial source of water entering the river, while the downstream is the lowest part of the river channel and closest to the estuary. Rivers are important ecosystems for human, animal, and plant life (Alfionita et al., 2019). As per Keraf's (2010) findings, rivers are extensively utilized by humans for various purposes such transportation, storing water, irrigating rice crops, housing, industry, livestock, and flood management. The balance of the river ecology is thought to be negatively impacted by rising human activities in river basins. This is because of the numerous human activities that result in the disposal of waste into rivers and the accelerating growth of the population (Ayyub et al., 2018).

Rivers can be used as a means of transportation, and river water can also be used in various fields such as agriculture, industry, and domestic. In rivers there are various types of aquatic biota that humans really need, such as fish. The growth of aquatic biota is largely determined by the quality of the water and the availability of food in it. However, the stability of the ecosystem in rivers can be damaged due to several factors, including human activities as users, which can make the river polluted (Alfionita et al., 2019).

Rivers that have good water quality will directly or indirectly be connected to the coast because usually the leading part of the river, namely the river mouth, is in direct contact with the coastal area. Coastal areas are areas that are important to manage from various planning and management points of view. The transition between land and sea in coastal areas has formed diverse and highly productive ecosystems and provides extraordinary economic value to humans (Pinontoan et al., 2023). The quality of the waters ultimately has an impact on the life of the biota in them. The occurrence of this change will kill even the most sensitive biota because the food network in the waters is disrupted (Susana, 1999).

One of the rivers in Barru district is the Wiringtasi River. At the forefront of this river is the mouth of the river and is in direct contact with the coastal area, and of course it is connected to the tides, where at high tide the river water usually becomes salty or brackish with higher salinity compared to other parts of the river, namely the upstream part of the river. In the water's journey from upstream to the estuary, there are several areas that it passes through, such as rice fields, aquaculture areas, and river estuaries that are directly connected to coastal areas. In relation to the use of rivers for fish cultivation, research has been carried out to see the potential and relationship between water quality conditions in the Wiringtasi River, Barru Regency, and the potential for developing fish cultivation.

2. Material and method

The research was carried out from July to September 2024 at Lawallu Village, Soppeng Riaja District, Baru Regency, South Sulawesi Province, Indonesia. The research was carried out by taking the research location, namely along the Wiringtasi River, starting from the rice fields, which are located far from the river mouth, to the area at the mouth of the Wiringtasi River, Barru Regency.

The tools used in this research were a dissolved oxygen meter, pH meter, refractometer, calculator, thermometer, stationery, and camera. This research uses a descriptive method with a purposive random sampling technique, namely deliberate and random sampling at the research location and measurements carried out in situ. The method for determining sampling points was carried out at three location points, namely location 1 around rice fields, location 2 around pond areas and beaches, and location 3, namely around the mouth of the Wiringtasi River.

Each location represents the study area. pH measurements are carried out using a pH indicator, namely by inserting the pH indicator into the water and then reading the constant number printed on the pH indicator. Temperature measurements are carried out using a mercury thermometer with a scale of 0-100 °C. The thermometer is inserted into the water for 3 minutes or until the pointer on the scale is constant. Salinity measurements are carried out using a refractometer by taking 1 drop of water sample and then dropping it on the surface of the refractometer and seeing the final limit on the scale (Sari et al., 2017). The data that has been collected is then processed and analyzed using descriptive analysis.

3. Results

3.1 Water Temperature (^{0}C)

Figure 1 shows that the water temperature in the river at the research location close to the rice fields shows a temperature difference that is not significantly different, but the highest water temperature is located at location 1, namely the location adjacent to the rice fields, namely an average temperature of 30.4 ^{o}C, and the lowest temperature is located at location 3, which is the research location around the mouth of the Wiringtasi River, Barru Regency.

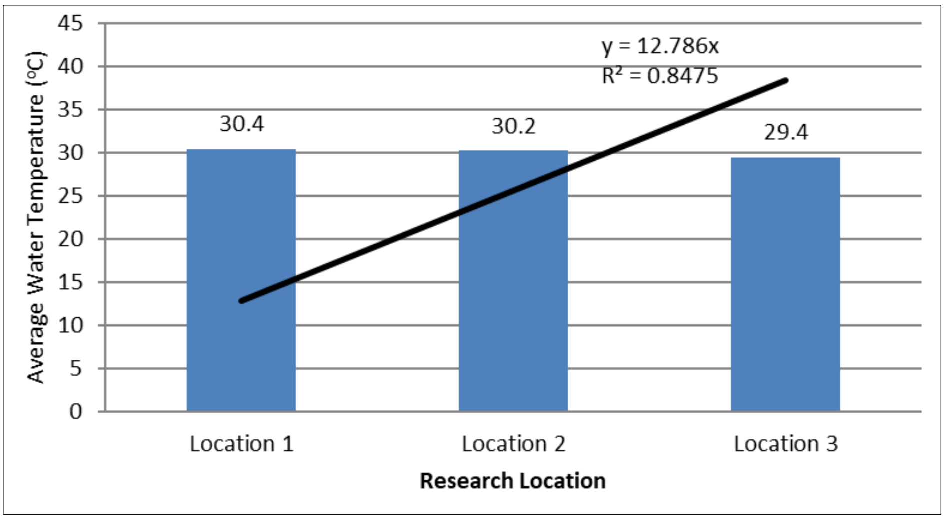

Figure 1 Average water temperature at the research location

3.2 Dissolved Oxygen (ppm)

Figure 2 shows that the highest average dissolved oxygen for the research location was obtained at location 2, namely the location around the pond and beach area, namely 5.08 ppm, and the location with the lowest average oxygen content was the location in the river around the rice fields, namely 4.31 ppm.

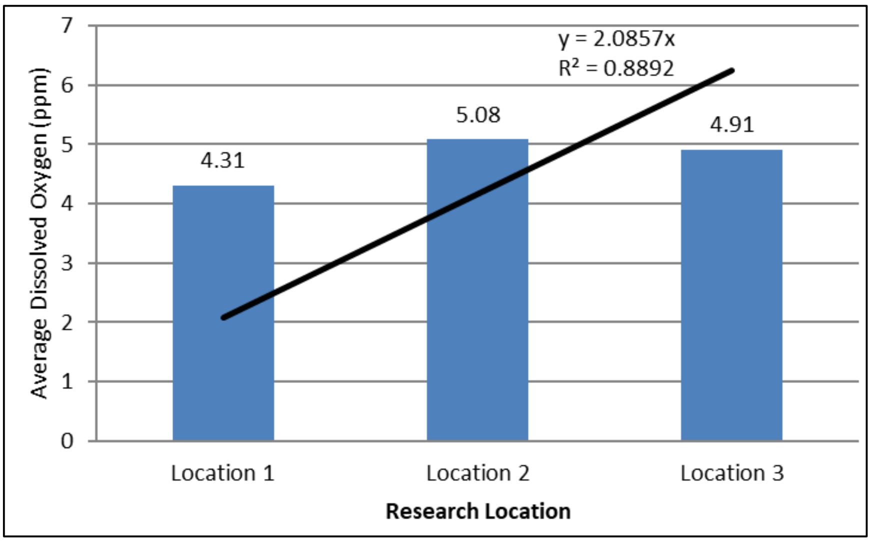

Figure 2 Average dissolved oxygen at the research location

3.3 Water pH

Figure 3 shows that the highest water pH value at the research location was at location 1, namely the location close to the rice fields, namely 7.11, and the lowest average water pH value occurred at location 2, namely the location around the river mouth. The low pH value of the water at location 2 is thought to be due to the fact that this location is a location where there is a lot of mangrove vegetation.

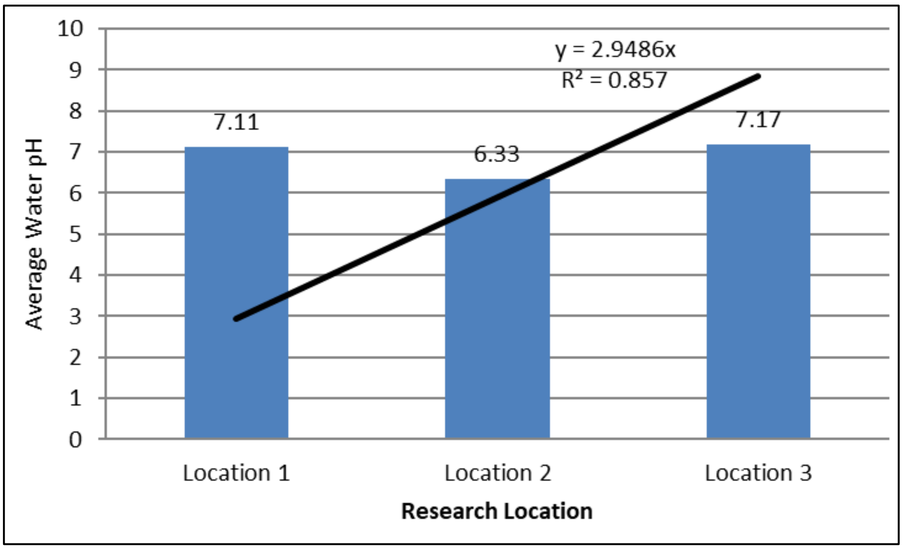

Figure 3 pH value of water at the research location

3.4 Water Salinity (ppt)

Figure 4 shows that the average water salinity at the research location is the highest at location 3, namely the location around the river mouth, which is an average of 36.83 ppt, while the research location with the lowest salinity is the location with a river close to the rice field area, namely an average of 12.67 ppt.

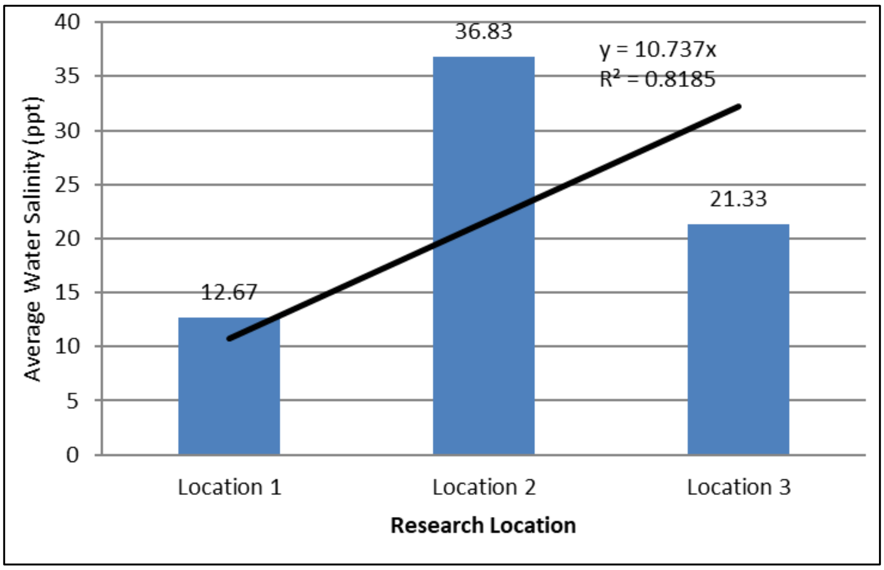

Figure 4 Average water salinity at the research location

4. Discussion

4.1 Water Temperature (°C)

Temperature plays a role in chemical reactions and biological processes, while salinity plays a role in the distribution of aquatic organisms, and dissolved oxygen is very important for the respiration of aquatic biota and decomposition processes (Sinaga et al., 2016). Sea water in waters close to the coast is warmer than water masses in offshore areas because of the heat that can be produced by the movement of water masses owing to friction between water molecules (Tarigan and Edward, 2000). According to Trisna et al. (2001), Indonesian surface water temperatures often fall between 28 and 31 °C. The lowest temperature was at Station 1, which was around 24 °C; this was because the sampling location was in a mountainous area and the sampling time was in the morning (Alfionita et al., 2019). Based on the temperature parameters, the Jeneberang river waters are classified as standard drinking water quality class II PP No. 82 of 2001. Rising temperatures can affect plankton. The optimum temperature range for phytoplankton growth in waters is 20–30 °C (Effendi, 2003). Meanwhile, according to Nontji (2002), surface water temperatures in Indonesian waters generally range between 28 and 31 °C. This means that river water temperature is able to support the growth of phytoplankton. Temperature's significant influence on phytoplankton abundance is probably related to light intensity, namely the tendency for temperature to increase following an increase in light intensity. Therefore, the direct influence of temperature in relation to metabolism may be relatively lower when compared to the influence of light on photosynthesis, which causes changes in growth and abundance of phytoplankton (Alfionita et al., 2019). The movement of water masses can generate heat as a result of friction between water molecules, so that the seawater temperature becomes warmer (Tarigan & Edward, 2000).

The results of temperature measurements in the Jeneberang River ranged between 24-30 °C (Nybakken, 1988); the temperature was 24 °C–29.8 °C (Alfionita et al., 2019). Differences in water temperature can be caused by topography or depth, which is related to differences in sunlight penetration in surface layers and deeper layers (Santoso, 2005). According to Nurfitriani et al. (2017) the temperature difference is caused by sunny/hot weather and the area is spacious. Goldfish grow normally at a temperature of 20 – 25 °C (Santoso, 1993). The minimum temperature limit of 24.5 °C is lower than the optimal temperature range for tilapia growth (El-Sayed and Mamdouh, 2008), namely 27.0 – 30.0 °C; which is based on the results of the study by Mizanur et al. (2014), temperatures lower and higher than the optimum water temperature significantly affect the growth, survival and feed efficiency of tilapia.

4.2 Dissolved Oxygen (ppm)

Dissolved oxygen is a water quality variable that is very important in cultivation activities. All aquatic organisms need dissolved oxygen for metabolism (Alfionita et al., 2019). Dissolved oxygen is the amount of dissolved oxygen in water in units of ppm. Dissolved oxygen in waters plays a very important role in the process of absorbing food by living creatures in water (Pinontoan et al., 2023). The photosynthesis process is optimal because in coastal areas, the water at the bottom of the waters, which contains lots of nutrients, is easily stirred into higher water bodies so that these nutrients can be utilized in the photosynthesis process (Santoso, 2005). Normal oxygen levels at sea level range from 5.7 to 8.5 ppm (Sutamihardja, 1978). Oxygen levels in lightly polluted sea waters in the surface layer are 5 ppm (Sutamihardja, 1978). The Ministry of the Environment of the Republic of Indonesia sets the threshold value for dissolved oxygen for marine biota at ≥5 ppm (Anonymous, 2004). If the waters do not contain toxic compounds (not polluted), an oxygen content of 2 ppm is sufficient to support the life of aquatic organisms (Swingle in Salmin, 2005). Phytoplankton and aquatic plants' photosynthetic processes also contribute to dissolved oxygen. Because there is insufficient sunlight for the process of photosynthesis, gloomy or rainy weather might impede the formation of phytoplankton (Alfionita et al., 2019). One element that might affect how dissolved oxygen is distributed in water is turbidity (Patty, 2013).

Dissolved oxygen levels in water masses are relative and variable, usually ranging from 614 ppm (Connell and Miller, 1995). Patty (2013) stated that the high levels of dissolved oxygen in offshore waters are because the water is clear so that oxygen can easily enter the water without obstacles through the diffusion process and photosynthesis process. Low oxygen levels in coastal areas near river mouths (estuaries) are closely related to the turbidity of sea water and are also thought to be caused by the increasing activity of microorganisms to decompose organic substances into inorganic substances using dissolved oxygen (bioprocess) in these waters. Meanwhile, the high levels of dissolved oxygen in offshore waters are due to the clear water so that oxygen can easily enter the water without obstacles through the process of diffusion and photosynthesis (Patty, 2013). This is different from what was stated by Nybakken (1988), that horizontally it is known that the deeper dissolved oxygen goes towards the sea, the dissolved oxygen levels will also decrease. However, this is not a benchmark (stipulation); it depends on the water itself in relation to the dissolved oxygen content. Low oxygen levels are closely related to the high levels of dissolved oxygen needed by microorganisms in the process of breaking down organic substances into inorganic substances, while the process of photosynthesis is decreasing (Simanjuntak, 2007). In addition, the abundance of biota, which uses oxygen for respiration, is assumed to be another factor contributing to the low oxygen levels at station 5.Organic molecules will be oxidized by reduced oxygen during the respiration process (Hamzah & Mukti, 2014). The results of dissolved oxygen measurements during the research were around 5.0–5.8 ppm (Toro et al., 2024). The standard water quality standards that have been stipulated in the Government Regulation of the Republic of Indonesia Number 22 of 2021 concerning the Implementation of Environmental Protection and Management set the minimum limit for dissolved oxygen in cultivation activities at 4 ppm.

4.3 Water pH

pH is the degree of acidity or alkalinity of a solution or liquid, which indicates the concentration of hydrogen ions ($H+$) (Dickson, 1993). The pH value is greatly influenced by the physical factors of the sediment as well as the dynamics of the concentration of organic materials in the sediment. Changes in sediment pH values can affect the distribution of microorganisms whose metabolism depends on the distribution of chemical factors, both pH and dissolved oxygen. Most microorganisms are very sensitive to changes in pH values in water. Changes in pH values will affect water biochemical processes; for example, the nitrification process will end if the pH is low (Effendi, 2003). Changes in the value of the degree of acidity (pH) and oxygen concentration, which act as indicators of water quality, can occur as a result of the abundance of chemical compounds, both pollutants and non-pollutants. Waste that flows into marine waters is generally rich in organic material, coming from various sources such as household waste, food processing, and various other chemical industries (Susana, 2009). Based on Government Regulation of the Republic of Indonesia Number 82 of 2001, the pH of water in the class II category is 6-9, meaning that the quality of the water can be used for water recreation infrastructure/facilities, cultivating freshwater fish, animal husbandry, water for irrigating crops, and/or other purposes, which requires the same water quality as the use (Alfionita et al., 2019).

The Cileungsi River was studied by Azizah and Humairoh (2015), and their findings indicated that the river's water at this initial location had a pH of 7.60 and a temperature of 26 °C. The second river, on the other hand, had a lower pH, measuring 7.32 at 26 °C, but it nevertheless satisfied the Indonesian Government Regulation No. 82 of 2001's quality standard standards (Azizah and Humairoh, 2015). Meanwhile, the research results of Alfionita et al. (2019), who conducted research on the Jeneberang River, showed that the water pH range was 6.28 to 7.98. The pH value in waters varies from the direction of the river to the sea; the higher you go to the sea, the higher the value (basic). Susana (1999) obtained pH values between 6.65 and 8.20 in her research at several river estuaries and the surrounding sea in the waters of Jakarta Bay. Low pH values are generally obtained in river bodies, and the higher you go towards the sea, the higher the value. A value between 6.5–8 is the safe limit for water pH for the biota living in it (Welch, 1980). that goldfish can grow normally at water pH values ranging from 7-8 (Santoso, 1993). The optimal temperature range for cultivating freshwater fish is 28–32 oC (Mas'ud, 2014). Republic of Indonesia Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management sets the standard for pH in cultivation activities; the minimum limit is 6-9.

4.4 Water Salinity (ppt)

The low salinity at location 1 in this study is thought to be due to the location being far from the mouth of a river or sea, so it is no less influenced by tides. Meanwhile, the results of research conducted by Pinontoan et al. (2023), who conducted research on dissolved oxygen and pH of processed mangrove water and coastal sediments in Bulutui Village, West Likupang District, showed a salinity range of 24.04–29.03 ppt. According to Klau et al. (2020), the effect of salinity on the daily growth rate of eelfish with a salinity of 7 ppt. Eels are able to grow well with a pH of 7.0–8.0 (Triyanto et al., 2019). According to Boyd (1990), the ideal pH for fish life is 6.5–9.0. Salinity in Indonesian waters generally ranges from 30-35 ppt. The description of the salinity in these waters indicates that the size of the salinity fluctuations is thought to be influenced by several factors, including water circulation patterns, evaporation, precipitation, and the presence of river flow (runoff) (Patty, 2013). One of the factors that influences distribution in waters is the contribution of the amount of fresh water entering marine waters. In shallower waters, fresh water intrusion can spread to the bottom of the waters, resulting in low salinity (Ismail & Ankiq, 2012).

5. Conclusion

Based on the results of water quality measurements that have been carried out, it can be concluded that the water quality in the Wiringtasi River, Barru Regency, is still suitable for the growth and survival needs of fish, making it suitable for fish farming. The water quality data measured includes temperature parameters, where the highest water temperature is located at location 1, namely the location near the rice fields, namely an average temperature of 30.4^{o}C, and the lowest temperature is located at location 3, namely the research location around the mouth of the Wiringtasi river. The highest average dissolved oxygen for the research location was obtained at location 2, namely the location around the pond area and the beach, namely 5.08 ppm, and the location with the lowest average oxygen content was the location in the river around the rice fields, namely 4.31 ppm. The highest average water pH value at the research location was at location 1, namely the location close to the rice fields, namely 7.11, and the lowest average water pH value occurred at location 2, namely the location around the river mouth. The average water salinity at the research location was highest at location 3, namely the location around the river mouth, with an average of 36.83 ppt, while the research location with the lowest salinity was the location with a river close to the rice fields, namely an average of 12.67 ppt.

Compliance with ethical standards

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Disclosure of conflict of interest

In this research there is no conflict of interest.

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