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# Analysis of physical, chemical and condition of mangrove ecosystems for development of mandrove crab cultivation (Scylla serrata, Forskal)

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## Abstract

The aims of this research are; (1) analyzing the physical and chemical characteristics of coastal waters in mangrove forest areas for the development of crab cultivation businesses (2) Assessing the condition of mangrove forest ecosystems, (3) testing prototypes of technology for crab cultivation businesses in mangrove forest areas. The benefit of the results of this research is to determine the feasibility of crab cultivation based on the biophysical and chemical characteristics of the coastal waters of the mangrove area, so that the cultivation business can be sustainable. To achieve this, a field survey was carried out by collecting primary and secondary data. Primary data includes physical and chemical parameters as well as mangrove forest conditions. The results of observations of the condition of the mangrove area, for the Important Index Value (INP) of mangroves, Rhizopora, sp sampling I (191.23), sampling II (181.72), sampling III (205.07), this shows that in sampling III for The Rhizopora sp type has a greater role in maintaining the sustainability of the ecosystem. For the dominance index value, the value for the entire station is 0.02 – 0.03. This shows that there is no species that dominates other species or the community is in a stable condition. Meanwhile, the species diversity index value in the entire sampling area has low species diversity, namely $0 < H < 2$. The results of physical observations of waters, the results of tidal data processing using the Admiralty method show that the mean sea level (MSL) is 200.41 cm, The lowest low sea level (LLWL) is 112.86 cm and the highest high sea level (HHWL) is 279.41 cm, the tidal range (range) is 166.36 cm. From the value of the Formzahl number (F value = 1.89) it can be concluded that the type of tide around the observation location is a mixed tidal type that tends to be single daily. The results of observations of water salinity parameters at the research location ranged from 25.0 - 27.1 ‰ with an average value of average 26.0 5 ‰, pH, nitrite ($NO_2$), nitrate ($NO_3$) and phosphate ($PO_4$) in water. The average pH value of 6.90, the average nitrite content value of 0.020, the average nitrate content value of 0.236 and the average phosphate content of 0.145 indicate good water quality for mariculture purposes, and also indicate the condition of the waters that have not been polluted.

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**Keywords:** Crabs, Mangroves, Suitability of waters, physics and chemistry of waters

## Introduction

Mangrove crab (Scylla serrata) is a fishery commodity that has high economic value. However, until now crabs are still mostly carried out by fishing activities alone. Domestic market demand and exports abroad continue to increase (Ministry of Maritime Affairs and Fisheries, 2017). Apart from that, crab fishing is often carried out using methods and tools or materials that are not environmentally friendly, causing damage to the crab habitat and the environment. If this condition continues, the crab population in nature will be increasingly threatened. However, until now crab rearing efforts for cultivation are still very limited.

There is concern that if this activity continues to be carried out with high frequency, the crab resources in this marine ecosystem will decrease day by day and overfishing could even occur and damage the marine resource ecosystem as a place for crabs to live (Rustam, 2015) [11]. To overcome the problem of declining crab populations in nature and damage to their habitat, it is necessary to carry out crab cultivation and environmental conservation efforts. The initial step in crab cultivation requires data on the physical, biological and chemical characteristics of the marine environment to determine the feasibility of crab cultivation (Seyono, 2006). To ensure sustainable cultivation business activities, it is necessary to analyze the biophysical and chemical characteristics of the crab environment to diversify the potential for sustainable mariculture. This is also reflected in UMI's superior research strategic plan which is related to the phasing of superior research in the field of natural (marine) resources, namely marine biota cultivation technology and environmental conservation. The outputs expected in this research include (1) identifying the physical, chemical and biological characteristics of the mangrove aquatic environment for crab cultivation, (2) the condition of the mangrove forest ecosystem (3) testing prototypes of technology for crab cultivation in mangrove forest areas. This study has a contribution to the development of science, especially the use of marine resources for technology activities for cultivating marine crab marine biota, environmental conservation of marine resources.

## Research Methods

### Research Location and Time

This research will be carried out in the coastal waters of the Lantebung mangrove, Bira Village, Makassar City from June to October 2023. The materials used in this research consisted of water quality chemicals, water samples, preservatives (4% formalin), label paper, and tissue paper. The tools used in this research include: scale stick, paralon pipe, compass, cool box, pH meter, electronic balance scale model ER-120A, oven, mercury thermometer, sample bottle, plastic bucket, plastic bag, filter paper, meter, as well as stationery.

### Types, Sources and Implementation Procedures

The data used in this research consists of primary and secondary data. Primary data was collected through direct observation and interviews at the research location and secondary data was collected through searching various documents and literature in various government and private agencies related to this research. Primary data observed in this research includes:

### Characteristics of Physical and Chemical Parameters of Coastal Waters

Data collection on physical and chemical parameters of observed waters, tools, methods and places of measurement can be seen in Table 1,

**Table 1:** Parameters Measured and Tools and Methods Used Based on APHA, 1998) **Physical-Chemical Waters**

| Parameters | Unit | Tools/Method Measurement | Location |
|---|---|---|---|
| Physical parameter | | | |
| ▪ Suhu | (oC) | Termometer air raksa | In situ |
| ▪ Tides | (cm) | Tide gauge milestones | Insitu |
| Chemical parameter Kimia: | | | |
| ▪ pH | - | pH-meter | Insitu |
| ▪ Salinity | (ppt) | Refractometer | Insitu |
| ▪ Ammonia | (ppm) | Samplebottle, Spectophotometer | laboratory |
| ▪ Nitrates | (ppm) | Sample bottle, Spectophotometer | laboratory |
| ▪ Phosphates | (ppm) | Sample bottle, Spectophotometer | laboratory |

### Mangrove Condition

Data on the biophysical characteristics of the mangrove forest ecosystem, including data on physical and chemical parameters, were taken by taking direct measurements in the field. Measurements are carried out at observation stations that are determined proportionally. Specifically for data on mangrove vegetation stands, observations were made using the Belt Transect Method which was placed purposively, starting from the edge of the mangrove forest ecosystem towards the land. The transect width used was 10 m (Bengen, 2014) [3]. Secondary data as support and comparison was obtained from various government agencies, mangrove observer groups that are related to the use, management and ecosystem of mangrove forests.

### Analysis of physical data on water chemistry

Physical and chemical parameter data is processed quantitatively and qualitatively, then analyzed descriptively-comparatively. The quantitative descriptive analysis intended here is interpreting data by looking at the magnitude values in the form of average values (Rauf, et al, 2020) [10]. Meanwhile, qualitative descriptive analysis means interpreting data by looking at the appearance of its quality. The parameters observed in this study were survival and growth of mangrove crabs.

## Results and Discussion

### Composition and Structure of the Mangrove Forest Ecosystem

Based on the results of observations of the mangrove forest ecosystem in Bira Village, Makassar City, the mangrove plants that build the mangrove forest ecosystem are generally the Rhizopora sp., and Sonneratia sp. types that dominate all growth levels and are found at all observation stations. Data from sampling results for mangrove forests in Bira Village, Makassar City can be seen in Table 1 below.

**Table 2:** Data from measurements of mangrove tree diameter in Bira Lantebung Village, Makassar City

| Mangrove tree diameter (cm) | Sampling I | Sampling II | Sampling III |
|---|---|---|---|
| 1 | 50 | 40 | 19 |
| 2 | 47 | 71 | 48 |
| 3 | 67 | 25 | 128 |
| 4 | 44 | 59 | 34 |
| 5 | 46 | 52 | 28 |
| 6 | 36 | 42 | 38 |
| 7 | 38 | 72 | 62 |
| 8 | 48 | 52 | 20 |
| 9 | 39 | 46 | 28 |
| 10 | 43 | 68 | 24 |
| 11 | 77 | 50 | 33 |
| 12 | 61 | 55 | 59 |
| 13 | 107 | 51 | 65 |

***Source*:** Field measurement data, 2023

Overall, the plant species found in the mangrove forest ecosystem in Bira Village, Makassar City are Avicenia sp and Rhizopora sp. (Table 2.) At sampling location 1, 1 type of plant was found in the mangrove ecosystem, namely Rhizopora sp and Sampling II found 1 type of mangrove plant, Avicenia sp., while at sampling location III, 2 types of mangrove plants were found, Rhizopora, sp and Avicenia sp., Forest ecosystem The mangroves in Bira Village, Makassar City are riverine mangroves, because the mangrove forest ecosystem is found on the right and left side of the river tributary. This is in accordance with the opinion of (Miththapala, 2008) [8], that there are three types of mangrove ecosystems, namely riverine mangroves, fringe mangroves and basin mangroves. Riverine mangroves, as the name suggests, are found along rivers and streams and are flooded throughout the day by tides. The location of the mangrove forest ecosystem is in Bira Village, Makassar City. The influence of tides and the flow of small rivers (Buntu) means that the mangrove forest ecosystem in Bira Village is always flooded with water. The volume of sea water entering from the sea is not too large because the mouth of the river estuary (dead-end river) is very small. This affects the relatively low salinity value of the water that inundates the mangrove ecosystem. The results of data analysis on the mangrove ecosystem in Bira Village, Makassar City are shown in the following table.

**Table 3:** Vegetation structure and tree level importance of mangrove plants in Bira Village, Makassar City

| Sampling | Mangrove Type | Di | RDi | Fi | RFi | Ci | RCi | INP | D | H' |
|---|---|---|---|---|---|---|---|---|---|---|
| Sampling I Sampling I | *Rhizopora, sp* | 0,22 | 57,89 | 1 | 33,33 | 56,13 | 100 | **191,23** | 0,34 | 0,32 |
| Sampling II Sampling II | *Avicenia sp* | 0,15 | 48,39 | 1 | 33,33 | 32,20 | 100 | **181,72** | 0,23 | 0,35 |
| Sampling III | *Rhizopora sp* | 0,33 | 71,74 | 1 | 33,33 | 48,99 | 100 | **205,07** | 0,51 | 0,24 |
| | *Avicenia sp* | 0,07 | 15,22 | 1 | 33,33 | | | | 0,02 | 0,29 |

Note: **Di**: Type Density; **RDi**: Relative Density; **Fi**: Type Frequency; **RFi**: Relative Frequency; **Ci**: Closure Type; **RCi**: Relative Cover; **INP**: Importance Value Index; **D**: Dominance Index; **H'**: Diversity Index

Based on Table 3 above, it can be seen the differences in each relative density (RDi) value at each observation station, in sampling 1 the species density was greater, namely 57.89 for the Rhizopora sp type, in sampling II 48.39, and sampling III 71.74. For relative frequency, it has the same value, namely 33.33, which shows that the distribution and presence of each type of mangrove is found throughout the observation sampling area. For relative cover in sampling I, it showed a greater value, namely for the Rhizopora type, namely 56.13 compared to sampling II 32.30 and sampling III 48.99. This shows that Rhizopora sp dominates more in sampling I. For the Important Index Value (INP), Rhizopora sp sampling I (191.23), in sampling II (181.72), in sampling III (205.07), p. This shows that in sampling III the Rhizopora sp type had a greater role in maintaining the sustainability of the ecosystem. For the dominance index value, the value for all observations is 0.02 – 0.03. This shows that there is no species that dominates other species or the community is in a stable condition. Meanwhile, the species diversity index value in all sampling areas has low species diversity, namely $0 < H < 2$ (Rustam, et al, 2023) [13].

## Physical and chemical parameters of coastal waters

**Table 3:** Data from Physical Water Measurement Results in Bira Village, Makassar City

| Sample | Salinity (‰) | pH | Temperature (oC) | $NO_3$ (mg/l) | $NO_2$ (mg/l) | $PO_4$ (mg/l) |
|---|---|---|---|---|---|---|
| 1 | 27,1 | 6,96 | 30,4 | 0,0994 | 0,0087 | 0,0803 |
| 2 | 25.0 | 6,94 | 30,7 | 0,0883 | 0,0072 | 0,0914 |
| 3 | 27.0 | 6,80 | 29,8 | 0,0929 | 0,0114 | 0,2392 |
| 4 | 25,1 | 6,88 | 29,1 | 0,2036 | 0,0205 | 0,1340 |
| 5 | 27,1 | 6,92 | 28,6 | 0,8839 | 0,0732 | 0,2274 |
| 6 | 25,0 | 6,88 | 30,6 | 0,0523 | 0,0037 | 0,0982 |
| Average | 26,05 | 6,90 | 29,87 | 0,236 | 0,020 | 0,145 |

***Source*:** Measurement data, 2023

In Table 3, the values of several physical water parameters in the mangrove ecosystem area in Bira Village, Makassar City can be seen. These physical parameter values are indicators of the current water conditions in the mangrove ecosystem area. The salinity value of the waters at the research location ranges from 25.0 – 27.1 ‰ with an average value of 26.0 5 ‰. The low value of water salinity is due to the influence of fresh water. And when the water salinity data was measured it coincided with the start of the rainy season. Low water salinity conditions are an indicator of the presence of mangrove plant species which are dominated by Rhizopora sp. Mangrove plants are generally able to adapt and have a high tolerance for water salinity conditions compared to non-mangrove plants. For example, Rhizophora mucronata seedlings can grow well at a salinity of 30‰ and R. apiculata can grow at a salinity of 15‰ (Bengen, 2000) [2]. This is different from the Sonneratia sp mangrove plant which is able to tolerate lower water salinity conditions. Indicators of water chemical conditions can be seen from the pH parameters and the content of nitrite (NO2), nitrate (NO3) and phosphate (PO4) in the water. The average pH value of 6.90, the average nitrite content value of 0.0208, the average nitrate content value of 0.2367 and the average phosphate content of 0.1451 indicate good water quality for fisheries purposes, and also indicate the condition waters that have not been polluted (Dahuri, 2019) [5]. This is in accordance with the explanation (Kathiresan et.al, 1999), that good water quality for fisheries is indicated by the pH value (6-9), nitrite content in the water (0.06 mg/l), while good water quality and not yet polluted, indicated by the pH value of the water (6-9), nitrate content (10 mg/l) and nitrite content (1 mg/l). Meanwhile, good water quality standards for fisheries are characterized by a nitrate content value of 5 mg/l and phosphate content of 0.5 mg/l (Widigdo, 2002). Tides are defined as the process of the periodic rise and fall of sea level which is caused by the gravitational force of celestial bodies, especially the moon and sun, on the mass of sea water on earth. Even though the mass of the moon is much smaller than the mass of the sun, because it is much closer, the influence of the moon's gravitational force on the earth is much greater than the sun's gravitational force (Dahuri, et al, 1996) [4]. The gravitational force of the moon1 which influences the tides is 2.2 times greater than the gravitational force of the sun. This phenomenon gives coastal and marine areas unique characteristics, causing different physical conditions in the waters. Based on the results of processing tidal data using the Admiralty method, it is clear that the mean sea level (MSL) is 200.41 cm, the lowest low sea level (LLWL) is 112.86 cm and the highest high sea level (HHWL) is 279.41 cm, the tidal range (range) is 166.36 cm. From the value of the Formzahl number (F value = 1.89) it can be concluded that the type of tide around the observation location is a mixed tidal type that tends to be single daily, where there are two high and low tides in a day but a single predominates with different maximum elevations. The description of the tides in Makassar waters refers to the results of tide measurements in Makassar for 15 days. Tidal conditions in Makassar Waters in the form of a tidal graph are presented in the following figure:

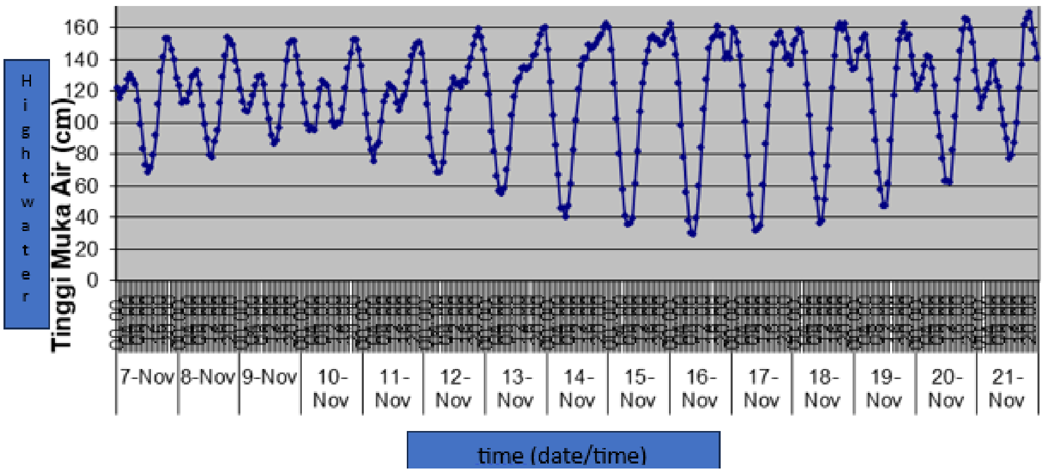


**Fig 1:** Tidal graph in Makassar waters

The position of the moon and the position of the sun always change relative to the earth, thus affecting the height of sea level (tidal range). If the moon and sun are in a straight line with the earth, their gravitational forces will strengthen each other, so there will be spring tides, where at high tide the sea level is very high and at low tide the sea water level is very low. However, if the position of the moon and sun form a right angle to the earth, then the gravitational forces of both will cancel each other out, neap tides will occur where the difference in sea level between high tide and low tide is only small (Rustam and Wamnebo, 2021) [12].

**Growth and survival of crabs**

Growth is the process of changing size (length, weight and volume) which is important in supporting the growth of mangrove crabs. Growth in mud crabs is an increase in body weight and carapace width that occurs periodically after molting. The observation results showed that the highest average absolute growth value for mud crabs was in the group given treatment B, namely 35.86 grams and the lowest absolute growth observed was in the group of mangrove crabs given treatment A, namely 3.87 g. Apart from that, the T test results showed that the treatment given had a very significant influence ($P \leq 0.01$) on the absolute growth of mud crabs. The results of the research showed that crabs fed crab food had better growth compared to crabs fed trash fish, this proves that crabs have a positive impact on the life and growth of mud crabs. Feeding crab crabs has a positive effect on the growth of mud crabs. It is suspected that crab crabs are a type of crab and are easy to eat by larger crabs because the crabs prefer to forage at the bottom of the water or at the bottom of research containers. Meanwhile, trash fish smell of food which is not the same as that of crustaceans. Apart from that, if the crabs given are floating then in the presence of wind they will easily collect in one place so that they are distributed unevenly. Thus, it can be stated that the growth of mud crabs fed with king crab feed has a fairly good growth effect compared to those given fish feed, reinforced by the statement, Growth is influenced by two factors, namely internal and external. Internal factors are factors that are difficult to control, including heredity, gender, age, resistance to parasites and disease and the ability to utilize food. External factors are food, physical and chemical conditions of waters, quantity and quality of food and space for movement. External factors What really influences growth is the availability of food. Food is a source of energy that fish need to live and grow. Food is used as a source of energy (metabolism) to drive all body functions and as a material for building body biomass (anabolism). The increase in crab biomass depends on the energy available in the crab's body and where this energy is distributed and used.). The difference between the size at the end and beginning of a time period expressed as a percentage of the size at the beginning of the time period. The results of the T test showed that there was a very significant effect ($P \leq 0.01$) on the specific growth rate of mud crabs. The specific growth rate values in this study ranged from 0.13% to 0.96%. The results of the research showed that the highest average specific growth rate was found in the group of mud crabs given treatment B, namely 0.96%. The high specific growth rate in this treatment is thought to be due to the treatment being given fresh crab crab feed so that the chance of being eaten by crabs is greater because crabs prefer to forage at the bottom of the water or at the bottom of containers and the nutritional composition contained in crab crabs fulfills the energy needs of mangrove crabs to grow. Compared to treatment A which is the treatment given to trash fish, thus causing treatment B to have a better specific growth rate, namely 0.13% to 0.96%. In treatment A the specific growth rate was only around 0.13%. This is influenced by the food given by crabs. They have a greater chance of being eaten by crabs because crabs have almost the same shape as mud crabs. From the results of the data above, it shows that the treatment given to the crabs in Treatment B was given fresh crab feed so that the chance of being eaten by crabs was greater because the crabs prefer to find food at the bottom of the water or at the bottom of the container and the nutritional composition contained in the crabs fulfills the energy needs of mangrove crabs to grow. . A well-controlled rearing environment and sufficient food can also support the high survival rate of mud crabs during the rearing period.

## Conclusions

1. The physical condition of tidal waters using the Admiralty method shows that the average sea level (MSL) is 200.41 cm, the lowest low sea level (LLWL) is 112.86 cm and the highest high sea level (HHWL) is 279. 41 cm, the tidal range (range) is 166.36 cm. From the value of the Formzahl number (F value = 1.89) it can be concluded that the type of tide around the observation location is a mixed tidal type that tends to be single daily. The results of observations of water chemical parameters, the salinity of the water ranges between 25.0 - 27.1 ‰ with an average value of average 26.0 5 ‰, pH, nitrite ($NO2$), nitrate ($NO3$) and phosphate ($PO4$) in water. The average pH value of 6.90, the average nitrite content value of 0.020, the average nitrate content value of 0.236 and the average phosphate content of 0.145 indicate good water quality for fisheries purposes, and also indicate the condition of the waters that have not been polluted.
2. Condition of the mangrove area, for the Important Index Value (INP) of mangroves, Rhizopora, sp sampling I (191.23), sampling II (181.72), sampling III (205.07), This shows that in sampling III for The Rhizopora sp type has a greater role in maintaining the sustainability of the ecosystem. For the dominance index value, the value for the entire station is 0.02 – 0.03. This shows that there is no species that dominates other species or the community is in a stable condition. Meanwhile, the species diversity index value in all sampling areas has low species diversity, namely $0 < H < 2$.

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