

Effect of Different Salinity on Growth and Survival of Mud Crab (*Scylla serrata*)

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ABSTRACT

Mud crab (*Scylla serrata*) is a group of crustaceans that live in mangrove and estuarine ecosystems. Mud crab have potential with high economic value and have a lot of interest from local and international communities because they have very high nutritional value. In cultivation activities, one of the factors that affect the growth and survival of mud crab is water quality. One of the most important water quality parameters in mud crab cultivation is salinity. Salinity is a water quality parameter that has a limiting factor on the metabolic and physiological conditions of mud crab. This study aims to determine the effect of different salinities on the growth and survival of mud crab (*Scylla serrata*). The method used in this study is an experimental method with a complete randomized design (CRD) consisting of 5 treatments and 3 replicates, namely P1: 5 g L⁻¹, P2: 10 g L⁻¹, P3: 15 g L⁻¹, P4: 20 g L⁻¹ and K (control): 28 g L⁻¹. The results showed that the best mud crab growth was in the 15 g L⁻¹ salinity treatment, the value obtained in absolute weight growth of 12.33 ± 4.93 g, the specific weight growth rate value of 0.28 ± 0.10%/day with a survival rate of 100%. It can be concluded that different salinity treatments have a significant effect on the growth and survival of mud crab.

INTRODUCTION

Mud crab (*Scylla serrata*) is one of the fisheries products that has high economic value and has a lot of interest from local and international communities. This is because mud crab has very high nutritional value, it was found that mud crab store 88.55% protein and 11.20% fat (Mukhlis *et al.*, 2022). Mud crab is one of the foods favored by foreign consumers and is a luxury food among them. One of the countries with demand for nearly 55% of mud crab production worldwide is United States of America. While other demand comes from countries in the European region and Asian countries such as Hong Kong, Taiwan, Japan, Singapore and South Korea (Masitah *et al.*, 2019).

The increasing demand for mud crab has caused the price of mud crab was rise.

According to the report Kementerian Kelautan dan Perikanan (2022), the export value of fisheries products in 2016 reached 29,040 million tons with a price value of US\$321,841 million and in 2021 a rapid increase of 31,702 million tons with a price value of US\$611,225 million. Therefore, mud crab production is expected to meet these market needs. However, there are factors that affect the growth and survival rate of mud crab, namely water quality parameters.

One of the most important water quality parameters in mud crab cultivation is salinity. Salinity is a water quality parameter that has a limiting factor in the metabolic and physiological conditions of mud crab. Metabolism has an important role in the growth and development of the body in mud crab. Salinity affects the concentration of fluids in the body of mud crab, therefore to obtain mud crab with high survival rates, it is necessary to review the metabolic aspects (Karim, 2008). This study aims to determine the effect of different salinities on the growth and survival rate of mud crab (*Scylla serrata*).

METHODS

Place and Time of Research

This research was conducted on June 8-July 23, 2024 at the Crab Cultivation Unit of CV Alula Dua Satu, Jl. Ahmad Yani No. 21, Sayang-Sayang Village, Cakranegara District, Mataram City.

Tools and Materials

The tools used include aeration as a source of oxygen with a diameter of 5 mm, stationery to record the results of practicum such as (books, pencils and pens), crab box as a container of biota tested with a size of 40 x 32 x 18, DO meter to measure dissolved oxygen with Lutron YK-22DO model, bucket for sampling tools with a size of 50 L, camera phone to document activities during the study, tray as a container when measuring crabs where the tray used is rectangular with a size of 30 cm x 40 cm, ruler to measure the length of the crab carapace, pH meter to measure the acidity of the water using a digital pH meter, refractometer to measure salinity using a brix meter refractometer model, thermometer to measure temperature where the brand used is Effosola thermometer, digital scales to weigh the weight of crabs using the SF400 model, measuring cup as a measure of making maintenance media, scissors to cut aeration hoses, scooppnett to catch crabs, sponges to clean crab boxes, claws to catch crabs, blower as an oxygen supply blower used Jebo P-50 type, jerry cans as seawater reservoirs with a size of 25 L and pipes as oxygen suppliers with a diameter of 1/2 inch. The materials used include sea water taken around Senggigi Beach, fresh water from boreholes, distilled water used to clean water quality tools, non-ionic detergent (sunlight) as a dirt cleaner on the crab box, 84-98 g mud crab obtained from crab farmers in Sekotong District, West Lombok Regency, and feed used in the form of rice snails, which come from Segerongan rice fields.

Research Methods

This study used an experimental method using a completely randomized design (CRD) consisting of 5 treatments and 3 replications, resulting in 15 experimental units. The treatment of salinity levels in this study refers to previous research conducted by Sitaba *et al.* (2017). The experimental units are as follows:

- P1 : Salinity level of 5 g L⁻¹
- P2 : Salinity level of 10 g L⁻¹
- P3 : Salinity level of 15 g L⁻¹
- P4 : Salinity level of 20 g L⁻¹

K (control) : Salinity level of 28 g L⁻¹

Research Procedure

The initial preparation carried out in this study is the preparation of maintenance containers that have been washed and dried and equipped with aeration in each crab box. Then the stage of entering the media into the crab box with a predetermined salinity with a water level of ± 5 cm or ± 4 L. The mud crab used are crabs caught by fishermen and from crab farmers in Sekotong District, West Lombok Regency. The crabs used weigh 84-98 g. The use of test crabs in this experiment refers to national standards based on the Badan Standardisasi Nasional (2023) in SNI:9057-3:2023. Mud crab that will be used are 15 male mud crab because male crabs grow faster than females (Mustofa *et al.*, 2022). Each crab box container is filled with 1 crab that has been adjusted to the environment (acclimatization) first for 3 days so that the body functions do not work too hard in the environment. To get the treatment media in accordance with the desired salinity, the dilution technique with fresh water needed to reduce salinity to 0 g L⁻¹ can use the following formula (Sahir *et al.*, 2022):

$$M1 \times V1 = M2 \times V2$$

Where:

M1 = Water Salinity in the container (g L⁻¹)

M2 = Dilution Water Salinity (g L⁻¹)

V1 = Water Volume in the Container (L)

V2 = Dilution Water Volume (L)

Mud crab maintenance in this study was carried out for 45 days. The feed used during the maintenance of mud crab is rice snails which are given according to the weight of their body weight. Feeding was carried out twice a day, in the morning and in the afternoon during maintenance with a feeding frequency of 15% of the crab's body weight. During the rearing period, siphoning and water was changed using two methods, namely water change every 2 days partially and water change once a week totally. Growth sampling was carried out once every 1 week on days 0, 7, 14, 21, 28, 35 and 42.

Absolute Weight Growth

According to Rachmawati *et al.* (2022) for the calculation of absolute weight growth of crabs can be calculated using the formula:

$$AW = W_t - W_0$$

Where:

AW = Absolute growth (g)

W_t = Average weight of crabs at the beginning of the study (g)

W₀ = Average weight of crab at the end of the study (g)

Specific Growth Rate (SGR)

Specific growth rate according to Sitaba *et al.* (2017) can be calculated using the following formula:

$$SGR = (\ln W_t - \ln W_0) \times t^{-1} \times 100\%$$

Where:

SGR = Specific Growth Rate (%/day)

W_t = Crab biomass at the beginning of the study (g)

W₀ = Crab biomass at the end of the study (g)

T = Maintenance time (days)

Survival Rate (SR)

Crab survival rate can be calculated by the formula (Pattirane & Pattiasina, 2020) using the following formula:

$$SR = (N_t \times N_0^{-1}) \times 100\%$$

Where:

SR = Survival Rate (%)

N_t = Number of crabs alive at the end of the study (crabs)

N_0 = Number of crabs alive at the beginning of the study (crabs)

Water Quality

The water quality parameters measured in this study are temperature, pH and dissolved oxygen (DO). Checking water quality is done once a week in the morning.

Data Analysis

The results of the study were analyzed using analysis of variance (ANOVA), if the test results between treatments are significantly different, it will be continued with the DUNCAN test at the 0.05 level.

RESULTS

Absolute Weight Growth

The results of absolute weight growth of mud crabs with different salinity treatments maintained for 45 days showed that the absolute weight growth obtained ranged from 4 - 12.33 g. Based on the results of the Anova test, the value of absolute weight growth of mud crabs with different salinity on survival has a significantly different effect ($P < 0.05$) The results of the analysis obtained are significantly different so that further tests can be carried out using DUNCAN, that the highest value is found in the P3 with a salinity of 15 g L^{-1} , namely with an average value and standard deviation reaching $12.33 \pm 4.93 \text{ g}$, then followed by P2 of $8.33 \pm 3.21 \text{ g}$, then P4 amounted to $5.67 \pm 1.53 \text{ g}$ and K of $5 \pm 2.00 \text{ g}$, while the lowest value is found in P1 with an average value and standard deviation obtained a value of $4 \pm 1.00 \text{ g}$.

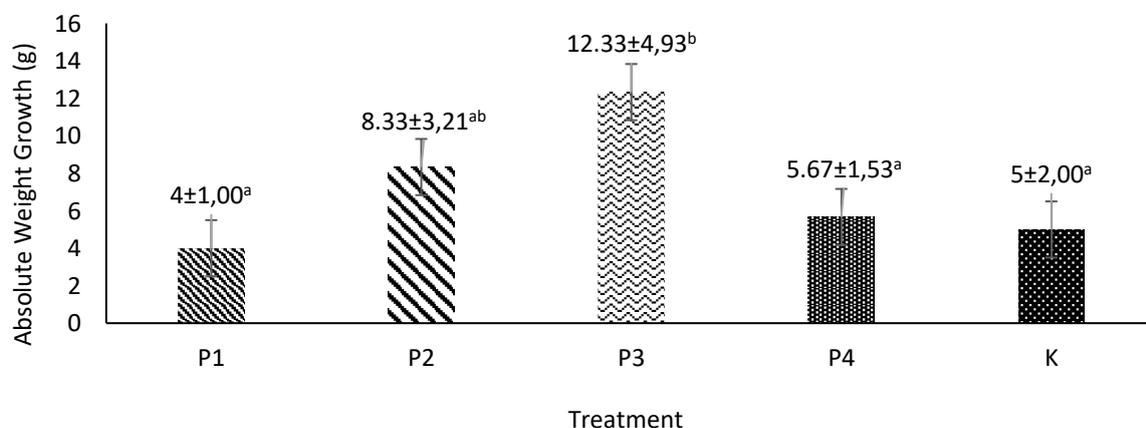


Figure 1. Absolute Weight Growth of Mud Crab After Different Salinity Treatments: (P1) 5 g L^{-1} , (P2) 10 g L^{-1} , (P3) 15 g L^{-1} , (P4) 20 g L^{-1} , and (K) 28 g L^{-1} . The Results Presented are Based on Data Normalization. Different Superscripts Indicate Significant Differences at a Confidence Level of 95% ($P < 0.05$).

Specific Growth Rate (SGR)

The results of the analysis of the specific growth rate of mud crab with different salinity treatments showed that the specific growth of mud crab ranged from 0.09-0.28%/day, as shown in Figure 2.

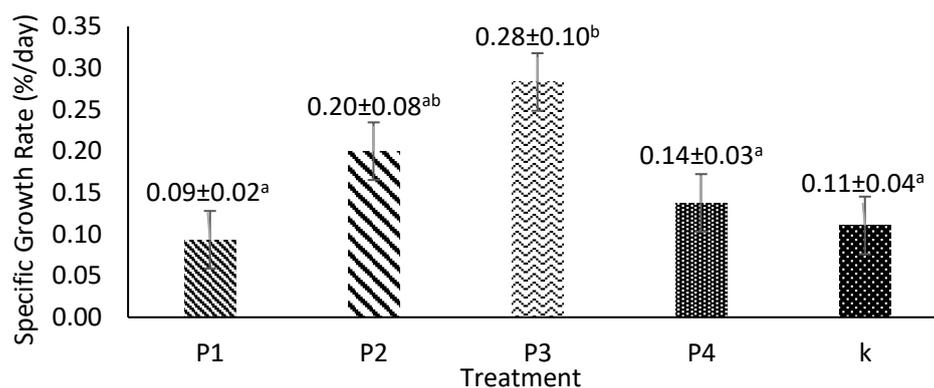


Figure 2. Specific Growth Rate of Mud Crab After Different Salinity Treatments: (P1) 5 g L⁻¹, (P2) 10 g L⁻¹, (P3) 15 g L⁻¹, (P4) 20 g L⁻¹, and (K) 28 g L⁻¹. The Results Presented are Based on Data Normalization. Different Superscripts Indicate Significantly Differences at a Confidence Level of 95% (P<0.05).

Survival Rate (SR)

The results of the analysis of the survival rate (SR) of mud crab with different salinity treatments show that the SR value of all treatments is 100%, as shown in Figure 3.

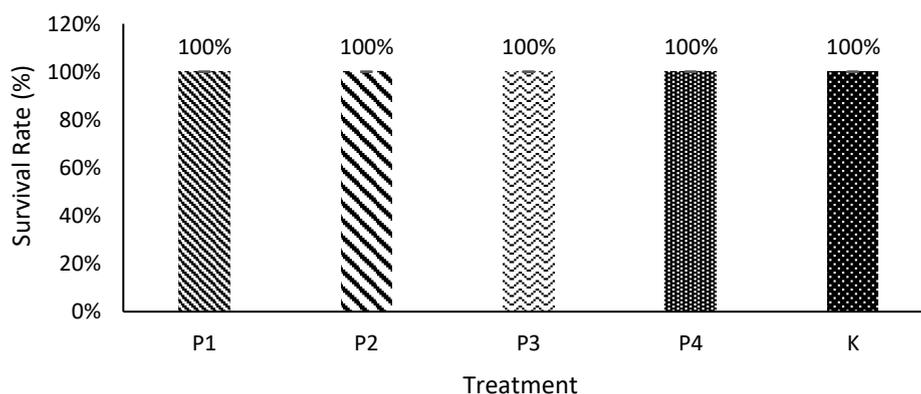


Figure 3. Survival Rate of Mud Crab After Different Salinity Treatments: (P1) 5 g L⁻¹, (P2) 10 g L⁻¹, (P3) 15 g L⁻¹, (P4) 20 g L⁻¹, and (K) 28 g L⁻¹. The Results Presented are Based on Data Normalization. Different Superscripts Indicate Significantly Differences at a Confidence Level of 95% (P<0.05).

Water Quality

The results of rearing mud crabs with different salinity media for 45 days show the value of water quality. Water quality results can be seen in Table 1.

Tabel 1. Water Quality of Mud Crab After Different Salinity Treatments

Treatments	Temperature (°C)	pH	Dissolved Oxygen (mg L ⁻¹)
P1	25.4 - 29.3	7.2 - 7.9	7.7 - 8.5
P2	25.3 - 29.3	6.9 - 7.4	7.7 - 9.4
P3	25.7 - 29.3	7.1 - 7.4	7.4 - 8.9
P4	25.7 - 29.2	7.1 - 7.5	7.6 - 9.1
K	25.1 - 29.1	7.2 - 7.9	7.4 - 9.2

Treatments	Temperature (°C)	pH	Dissolved Oxygen (mg L ⁻¹)
Optimum Range	24 - 35°C (Hastuti et al., 2019)	6.5 - 9 (Rachmawati et al., 2022)	>5 mg L ⁻¹ (Ardian et al., 2022)

Note: P1 = 5 g L⁻¹, P2 = 10 g L⁻¹, P3 = 15 g L⁻¹, P4 = 20 g L⁻¹, K = 28 g L⁻¹.

DISCUSSION

Absolute Weight Growth

Absolute weight growth is a parameter used to understand absolute weight growth (g) from the difference between initial biomass and final biomass. Based on the results of the research that has been analyzed, it shows that the results of growth are increasing from the beginning of maintenance to the end of the maintenance period. The results of the highest absolute weight growth rate value are in P3 (15 g L⁻¹) getting an average value of 12.33 ± 4.93 g which gives a value of absolute weight growth rate significantly different from other treatments. Growth in P3 is the highest growth due to the test crab at 15 g L⁻¹ salinity can perform physiological responses or balance the absorption of fluids in the body optimally at different salinities and utilize energy from feed used for growth rather than for the osmoregulation process. According to Sitaba *et al.* (2017) stated that crabs get energy from the food eaten and are used for various activities in the body including for osmoregulation purposes. Fast growth is not only determined by the efficiency of feed utilization, but also a low osmotic load. Mustofa *et al.* (2022) reported that growth at 15 g L⁻¹ salinity resulted in the highest absolute growth rate (10.52 g). However, there are studies that state that the results of the study are different, where the results of the study obtained a positive correlation between growth and salinity. Sitaba *et al.* (2017) reported that the best test crabs were at 10 and 20 g L⁻¹ salinity.

While the lowest growth is in P1 (5 g L⁻¹) where the growth in P1 is more likely to perform high osmotic work as a physiological response or balance the absorption of fluids in the body of the test crab and utilize more energy used to regulate the concentration of body fluids. This shows that differences in salinity can significantly affect the absolute growth of the test crabs. Mustofa *et al.* (2022) stated that salinity changes that occur continuously can inhibit growth because the energy derived from food will be used up to regulate the balance of body fluids in mud crab.

Specific Growth Rate (SGR)

Based on the results of the anova test, the specific growth rate of mud crab with different salinity has a significantly different effect ($P < 0.05$). The results of the analysis obtained are significantly different so that further tests can be carried out using DUNCAN. The results showed that the highest value was found in the P3 with a salinity of 15 g L⁻¹, namely with an average value and standard deviation reached $0.28 \pm 0.10\%$ /day, and the results of the lowest specific growth rate were in the P1 with a salinity of 5 g L⁻¹ obtained a value of $0.09 \pm 0.02\%$ /day. The results on the graph show that the P3 with a salinity of 15 g L⁻¹ is the best salinity to support the growth rate of mud crab.

Specific growth rate is a parameter used to determine the growth of mud crab every day during the maintenance period. Based on the results of the study, it shows that the highest specific growth rate value is found in P3 (15 g L⁻¹) which amounted to $0.28 \pm 0.10\%$ /day the results of the specific growth rate in P3 provide a specific growth rate that is significantly different from the other treatments. This indicates that the salinity of 15 g L⁻¹ is the best

salinity, where the storage and utilization of energy from consumed feed is used more for weight growth than for osmoregulation.

In the P1 (5 g L⁻¹) is the lowest specific weight growth with a value of 0.09 ± 0.02%/day. This happens because the difference in salinity results in a decrease and increase in daily growth in mud crabs where if the salinity is not in accordance with the environment, the mud crab will perform osmotic work for osmoregulation purposes, which will regulate the concentration of water and ion balance in the body and its environment through the process of osmotic pressure that will continue, so that the energy in the body of mud crabs derived from food will be used up for the process of adjusting to salinity differences. According to Rachmawati *et al.* (2022) stated that mud crab growth can occur if the energy stored is greater used for growth than the energy used for body activities. Kaligis (2016) states that when there is a change in salinity, the amount of salt in the cell will be unstable so that there will be an absorption of water by osmosis from the blood. In the arrangement of ions will be discharged through urine and through diffusion in the body. If this continues, the energy for growth will be used up in the process.

Survival Rate (SR)

Based on the results showed that the survival rate (SR) of mud crab at different salinities obtained 100% in each treatment, so there was no need to do anova analysis and further tests using Duncan because the results of each treatment were not significantly different.

Survival rate is a parameter used to describe the number of biotas that survive during the maintenance period in cultivation activities. Based on the results of studies, the highest survival rate of mud crab was found in all treatments, namely P1 (5 g L⁻¹), P2 (10 g L⁻¹), P3 (15 g L⁻¹), P4 (20 g L⁻¹), and K (28 g L⁻¹) with a SR value of 100%. The results of the survival rate of mud crab from all treatments showed that it was not significantly different in each treatment. The high survival rate of mud crab is due to the absence of cannibalism due to food competition, where each treatment is only filled with 1 mud crab so that food intake and dissolved oxygen are fulfilled. According to Adila *et al.* (2020) stated that mortality is caused by competition for space in the struggle for food and cannibalism towards mud crab. Mud crab can adjust to different salinities so that they can survive in different salinities, besides the absence of pests and diseases.

Water Quality

Water quality is a parameter that plays an important role in the survival of mud crabs. Water quality measured during this study were temperature, pH and dissolved oxygen (DO). The average results of water quality measurements during the study obtained an average temperature value of 25.1 - 29.3°C, pH 6.9 - 7.9, and dissolved oxygen (DO) 7.4 - 9.4 mg L⁻¹.

Temperature is a major limiting factor for aquatic biota. Because temperature is an abiotic factor that can affect appetite, activity, growth rate, oxygen consumption, and affect the moulting process. The results of temperature measurements during maintenance showed that the temperature in the mud crab rearing media ranged from 25.1 - 29.3°C, the temperature value was considered feasible to support the growth and survival of mud crab. This is in accordance with the statement of Hastuti *et al.* (2019) that the ideal temperature for growth and survival of mud crabs is 24 - 35°C.

pH is the degree of acidity of a body of water which is an indicator of the acid-base level in that place. pH is very influential on the survival rate of mud crab. The results of pH measurements during maintenance showed that the pH of mud crab rearing media water ranged from 6.9 - 7.9. The results of these values are in the optimal range to support the growth and survival rate of mud crab. According to Rachmawati *et al.* (2022) that the optimum

pH media will have the maximum growth impact on mud crabs because it is related to the degree of acidity and freedom in the waters, the pH of water for mud crab maintenance is 6.5 - 9.0.

Dissolved oxygen (DO) is the amount of dissolved oxygen in a water body. Dissolved oxygen is one of the parameters that determine the success rate of cultivation. The results of dissolved oxygen measurements during rearing showed that the dissolved oxygen of mud crab rearing media ranged from 7.4 - 9.4 mg L⁻¹. This value is optimal for the growth and survival rate of mud crabs. This is reinforced by the statement of Ardian *et al.* (2022) stated that the optimal DO for mud crab growth is >4 mg L⁻¹, while the optimal amount of oxygen for mud crab growth is >5 mg L⁻¹.

CONCLUSION

The conclusion obtained in this study is that differences in salinity have a significant effect on the growth and survival of mud crab. The parameters that have a real effect on this research are the absolute weight growth parameter and the specific growth rate (SGR). The value obtained in the research results of the best mud crab growth is at 15 g L⁻¹ salinity, the value obtained in absolute weight growth of 12.33 ± 4.93 g, specific growth rate of 0.28± 0.10%/day with a survival rate of 100%. The results showed that 15 g L⁻¹ salinity is the recommended salinity for mud crab growth in crab box system cultivation.

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