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Study of Growth and Survival of Mud Crab (*Scylla serrata*, Forskal) with Different Salinity Levels in culture media

Eddiwan^{1*}, T Dahril¹, Adriman¹, Budijono¹, Efawani¹, Y Harjoyudanto¹

¹Department of Water Resources Management, Faculty of Fisheries and Marine Science, Universitas Riau. Jl. HR. Subrantas Km 12.5 SimpangBaruPanam, Pekanbaru, Indonesia

*Email: eddiwan@lecturer.unri.ac.id

Abstract. The aim of this study to find out the optimal level of salinity for the growth and survival of the mud crab (*Scylla serrata*). The weight of crab seeds were about 47.65-51.32 grams and the carapace length ranged from 64.35-71.30 mm, then put into 12 tanks (1 m x 1 m x 0.4 m) with a density of 4 crab seed per tank. During the maintenance of this test, mangrove crab was fed with fresh chicken intestines as much as 10% of its body weight per day. Water changes are carried out more than 150% per week. At the beginning of the experiment, each tank was conditioned to the same water salinity in all experimental units, namely 33 ppt. To see the effect of differences in salinity levels on the growth and survival of mud crabs, 4 treatments were made consisting of (A) 33 ppt salt content, (B) 31 ppt salt content, (C). The salt content is 29 ppt, and (D) the salt content is 27 ppt. From the results of this experiment, it is known that a decrease in the salt content of 4 ppt is the best treatment for the growth of mud crabs, but has no effect on the survival value.

1. Introduction

Mud crab (*Scylla serrata*) is a type of crustacean that has high economic value and lives in coastal waters, especially mangrove forests [1]. Mud crabs prefer to live in relatively shallow waters, with muddy bottoms. According to [2], the criteria for suitable land as a cultivation location are muddy ponds with a temperature of 25-35 C, pH 7-9, DO > 5 ppm, and salinity value ranged from 10-30 ppt. The development of mud crab culture so far has not been as fast as tiger prawns (*Penaeus monodon*) or vannamei shrimp (*Litopenaeus vannamei*). One of the unresolved obstacles in the maintenance of mangrove crabs so far is the problem of ideal salinity for the growth and survival of mangrove crabs [3].

One of them is the change in the salinity of pond water. Changes in salinity will affect the physiology and morphology of organisms through the process of osmoregulation or fluid balance and the coefficient of absorption of fluids in the organism's body, while in the environment it causes changes in the saturation of dissolved gases, density, and viscosity [4]. [5] prolonged changes in salinity, especially if it is outside the tolerance limit, will inhibit growth and even cause death because the energy derived from the feed is used up in regulating the concentration of body fluids. [6] stated that the salinity tolerance limit for mud crabs is quite large at 15-35 ppt. According to [7]; [8], *S. serrata* is classified as a hyper osmoregulation at salinity below seawater salinity and even has the ability to survive.



The high to salinity is less than 5 ppt. Information on decreasing salinity is needed because it will have a maximum growth impact on mud crabs related to the osmoregulation process, and its subsequent application in the pond environment. This study aims to obtain optimal salinity reduction for the growth and survival of the mud crab, *S. serrata*. It is hoped that the results of this study can be used as information material for the development of mud crab cultivation.

2. Methodology

The mangrove crab test animals used had an initial weight range of 47.65 ± 51.32 grams and a carapace width of 64.35 ± 71.30 mm. Maintenance uses a container in the form of a tub measuring 1 m x 1 m x 0.5 m. The inside of the tub is covered with plastic and filled with 5 cm of sand as a substrate and 10 cm of water. Each tub is equipped with aeration and clumps of raffia as protection. The test animals were then put in a tank with a density of 4 individuals per tank. Routine feeding and salinity regulation are carried out. The feed used was fresh chicken intestines as much as 10% of body weight per day with a frequency of twice a day. In the beginning, the salinity of each tank was the same (33 ppt). Each week each tank unit was subjected to a different salinity reduction according to treatment (except control). Dilution is done by adding fresh water.

This study used a completely randomized design with four treatments and three replications, namely: treatment A (fixed salinity 33 ppt/control), treatment B (salinity decreased 2 ppt per week), treatment C (reduced salinity by 4 ppt per week), and treatment D (reduced salinity by 6 ppt per week). The variables measured every week were the growth in weight and width of the carapace and the survival rate at the end of the study. The formulation of the variables used in the study is as follows.

1. Growth in absolute weight [9].

$$h = W_t - W_o$$

where :

h = Average absolute weight growth of individuals (gr)

W_t = Average individual body weight at time t (gr)

W_o = Average individual initial weight (gr)

2. Average absolute carapace width of individuals [9].

$$I = L_t - L_o$$

where :

I = Average individual absolute carapace width growth (mm)

L_t = Average individual carapace width at time t (mm)

L_o = Width of the average individual initial carapace (mm)

3. Determination of daily weight growth and average daily carapace width was calculated based on the method of [10].

$$\ln W_t - \ln W_o$$

$$SGR = 1/t \times 100\%$$

where :

SGR = Daily individual growth rate (%)

W_t = Average carapace weight/width over time (gr)/(mm)

W_o = Initial average carapace weight/width (gr)/(mm)

4. Life pass rate [9].

$$S = N_t/N_o \times 100\%$$

where :

S = Life pass rate (%)

N_t = Final Population (tails)

No = Initial population (tail)

To determine the effect of treatment on absolute weight growth, daily weight, and absolute carapace width, and daily carapace width, and survival rate, analysis of variance was used. If there is a difference, further analysis is carried out using the Least Significant Difference (BNT) test according to [11] instructions.

3. Results and Discussions

Data on the absolute weight growth and average daily weight of mangrove crabs for 6 weeks can be seen in Table 1. The results obtained by measuring the absolute weight and daily weight of individuals showed that there was weight gain every week. Analysis of variance on absolute growth and daily growth showed the effect of treatment. The results of the BNT test showed that treatments A (control), B (2 ppt decrease) and C (4 ppt decrease) gave the same effect on the absolute weight growth rate, but in treatment D (4 ppt decrease) different growth rates were obtained. The BNT test on daily weight growth showed that treatments A and B were not different from treatment C, but treatments B and C were different from treatment D.

The effect of each treatment showed that the treatment with a decrease in salinity of 6 ppt obtained the lowest absolute growth rate and daily growth. This is due to the high rate of decrease in salinity, from 33 ppt at the start of the study to 3 ppt salinity for 6 weeks. Changes in salinity conditions cause functional properties to be disturbed [4], so that the osmoregulation process to balance body fluids with the environment will continue [12]. [13] Stated that to be able to adapt to the changing salinity of the environment, crabs will change the concentration of body fluids according to their environment through the process of osmosis and diffusion. According to [7], the type of hyper osmoregulation including mud crabs has the ability to survive because it is able to regulate the osmotic concentration of the body in balance with the environment. [14] states that when there is a change in salinity, the concentration of ions in the cell will be disturbed so that it will absorb water by osmosis from the blood [15]. In this setting, the ions are excreted through the urine as well as by diffusion on the body surface. If this continues then the energy for growth will be exhausted just for the process.

Table 1. Growth of absolute weight and daily weight of mud crab for 6 weeks

Treatment	Absolute growth (grams)	Daily growth (%)
A	9,6950	0,5107
B	10,2067	0,5247
C	11,6800	0,6041
D	7,6100	0,4110

Table 2. Growth of absolute carapace width and daily carapace width of mud crab for 6 weeks.

Treatment	Absolute width growth (mm)	Daily width growth (%)
A	5,9300	0,2210
B	6,2900	0,2316
C	7,2400	0,2644
D	4,4933	0,1684

Treatments A, B, and C showed that the salinity in all these treatments was sufficient to support the growth of crabs. Crabs need optimal salinity as the crab ages, and according to [4], the range of total salinity will vary according to age and life stage. The decrease in salinity up to 4 ppt was able to support the growth of crabs. Under conditions of good salinity, energy storage occurs for growth. The growth rate of carapace width and daily carapace width of individual mud crabs for 6 weeks can be seen in Table 2. The growth of absolute carapace width and daily carapace width showed a tendency to increase. Analysis of variance showed the effect of treatment. The absolute growth BNT test showed that the control treatment (A) and the salinity reduction of 2 ppt (B) were not different from

the 4 ppt (C) salinity reduction treatment, but the A, B, and C treatments were different from the 6 ppt salinity reduction treatment (D) while the BNT test Individual daily growth showed that treatment A was not different from treatment B, C, and D but treatment B and C were different from D. The absolute carapace width growth and the lowest daily width growth were shown in treatment D (6 ppt decrease in salinity) due to unsuitable conditions. So that the carapace growth process slows down. According to [13], internal and external environmental factors affect the molting process, and the low frequency of molting results in an increase in the width of a small carapace, whereas every time juvenile crabs molt, the carapace width increases by about 21-44.8% [16].

Treatments A, B, and C have the same effect on carapace growth rate and carapace width This supports the high weight growth results obtained in such salinity treatments. The range of changes in salinity up to 4 ppt is thought to be more similar to the mangrove crab habitat in nature when salinity fluctuations occur. The survival rate of mangrove crabs during the study ranged from $76.24 \pm 88.62\%$. The results of analysis of variance showed that the rate of decrease in salinity did not affect the survival rate of mud crabs, meaning that a decrease in salinity up to 6 ppt per week for 6 weeks of rearing did not decrease the survival rate of mud crabs. These results illustrate that mangrove crabs are euryhaline organisms with a very wide salinity tolerance and a decrease of up to 6 ppt per week is still tolerated with high survival rates. [7][8] Reported that salinity above seawater salinity, *S. serrata* was not able to adapt well, but was able to adapt (hyperosmoregulator) at a salinity of 5-35 ppt [17].

4. Conclusion

From the results of the study, the following conclusions can be drawn. (1). The rate of decrease in salinity of up to 4 ppt per week can provide optimal growth of mud crabs both in terms of body weight and carapace width., (2). The rate of decrease in salinity has no effect on the survival rate of mud crabs.

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