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ANALYSIS OF THE GROWTH RATE AND MOULTING FREQUENCY OF MUD CRAB (*Scylla serrata*) UNDER DIFFERENT REARING SUBSTRATES

Analisis Laju Pertumbuhan dan Frekuensi Pergantian Kulit Kepiting Bakau (Scylla serrata) dengan Substrat Pemeliharaan yang Berbeda

Asti Amalia[1]*, Laily Fitriani Mulyani[2], Muhammad Marzuki[3]

Aquaculture Study Program, Department of Fisheries and Marine Science, Faculty of Agriculture, University of Mataram

Pendidikan Street No 37, Mataram City, West Nusa Tenggara

*Corresponding email: amaliaasti86@gmail.com

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ABSTRACT

Mud crab (*Scylla serrata*) is a high-value fishery commodity, but the success of its culture is still influenced by growth and moulting processes. This study aimed to analyze the effects of different rearing substrates on the growth rate, moulting frequency, and moulting time of mud crab. The study was conducted at the Dakota Crab Culture Facility, Mataram City, and the Aquaculture Environment Laboratory, Aquaculture Study Program, University of Mataram. An experimental method was used with two treatments, namely P1, a beach sand substrate, and P2, a beach sand substrate with the addition of mangrove leaves. Rearing was carried out in crab boxes connected to a Recirculating Aquaculture System (RAS). The main parameters included moulting frequency, moulting time, absolute weight gain, absolute length growth, Specific Growth Rate (SGR), and Survival Rate (SR). The data were analyzed using a two-sample t-test assuming unequal variances at the 5% level. The results showed that substrate differences had no significant effect on any parameter ($p>0.05$). Descriptively, treatment P2 produced a higher moulting frequency of 0.500±0.534 times/day than P1 at 0.375±0.517 times/day. Moulting time in P2 was also slightly faster, at 38.00±16.4 days, whereas P1 was 39.67±11.3 days. Thus, the combination of beach sand and mangrove leaves tended to be better for moulting frequency and moulting time, but the differences were not statistically significant.
Keywords: Growth; Mangrove Leaves; Moulting; Moulting Time; Mud Crab; Substrate

ABSTRACT

Mud crab (*Scylla serrata*) is a high-value fishery commodity, but its culture success is strongly affected by growth and *moulting* processes. This study aimed to analyze the effect of different rearing substrates on the growth rate, *moulting* frequency, and *moulting* time of mud crab. The study was conducted at the Crab Culture Installation, Dakota, Mataram City and at the Aquaculture Environment Laboratory, Aquaculture Study Program, University of Mataram. An experimental method was applied with two treatments: P1, beach sand substrate, and P2,

beach sand combined with mangrove leaves. Crabs were reared in *crab box*es connected to a *Recirculating Aquaculture System* (RAS). The main parameters observed were *moulting* frequency, *moulting* time, absolute weight gain, absolute length growth, *Specific Growth Rate* (SGR), and *Survival Rate* (SR). Data were analyzed using a two-sample *t-test* assuming unequal variances at a 5% significance level. The results showed that different substrates had no significant effect on all observed parameters ($p>0.05$). Descriptively, P2 produced higher *moulting* frequency (0.500±0.534 times/day) than P1 (0.375±0.517 times/day). *Moulting* time in P2 was also slightly faster, at 38.00±16.4 days, compared with 39.67±11.3 days in P1. Therefore, the combination of beach sand and mangrove leaves tended to provide better *moulting* frequency and *moulting* time, although the differences were not statistically significant.
Key words: Growth; Mangrove Leaves; *Moulting*; *Moulting* Time; Mud Crab; Substrate

INTRODUCTION

Mud crab (*Scylla serrata*) is a fishery commodity with high economic value and is widely favored by the public because of the taste and nutritional content of its meat. The potential for mud crab development in Indonesia is considerable because this species is commonly found in coastal areas, particularly in mangrove ecosystems (Halipatulfikri et al., 2020; Tambunan & Supratman, 2023). However, utilization that still depends on wild catches may place pressure on populations; therefore, culture activities need to be developed sustainably.

The success of mud crab culture is strongly influenced by growth and the moulting process. Moulting is the process of replacing the exoskeleton, which enables an increase in body size; however, during this phase, crabs are weak and vulnerable to stress, environmental disturbances, and mortality (Djunaedi, 2016; Tahya & Akbar, 2025). Therefore, a rearing medium capable of providing protection and suitable microhabitat conditions is an important factor in supporting mud crab growth.

One environmental factor associated with successful moulting is the rearing substrate. The substrate functions as the bottom medium and a shelter and helps create conditions resembling the natural habitat. A suitable substrate can reduce stress and the risk of cannibalism, whereas an unsuitable substrate may reduce moulting frequency and survival. This study aimed to analyze the effects of different rearing substrate types on the growth rate and moulting frequency of mud crab (*Scylla serrata*).

RESEARCH METHODS

Time and Location

The study was conducted at the Crab Culture Facility, Dakota, Selaparang, Mataram City, and the Aquaculture Environment Laboratory, Aquaculture Study Program, Department of Fisheries and Marine Science, University of Mataram.

Equipment and Materials

The equipment used in this study included aquariums measuring 34 x 14 x 34 cm, crab boxes measuring 40 x 30 x 10 cm, RAS circulation pipes, a pH meter, refractometer, thermometer, DO meter, cutting scissors, vernier caliper, and digital scale. The materials used were 32 mud crabs (*Scylla serrata*) weighing 100-150 grams, seawater, freshwater, and trash fish.

Experimental Design and Procedure

The study used a Completely Randomized Design (CRD) with 2 treatments and 8 replications. The method used was an experimental method with two substrate treatments, namely P1, consisting of a beach sand substrate, and P2, consisting of a beach sand substrate combined with mangrove leaves. The mud crabs used had an initial weight of approximately

100-150 g and were selected in a healthy and active condition, without injuries to the carapace, legs, or claws, and had not yet undergone moulting. Before treatment, the crabs were acclimatized for 2-3 days.

Rearing was carried out using crab boxes and aquariums connected to a Recirculating Aquaculture System (RAS). The containers were cleaned before use and then filled with filtered seawater. The substrates were cleaned beforehand and placed according to the treatment. During rearing, the crabs were fed trash fish ad libitum twice daily at 08:00 and 16:00 Central Indonesia Time (WITA), while uneaten feed and waste were periodically removed to maintain water quality.

Data Analysis

The main parameters observed included moulting frequency, moulting time interval, absolute weight gain, absolute length growth, Specific Growth Rate (SGR), and Survival Rate (SR). Moulting was observed daily, while growth sampling was conducted weekly by weighing body weight and measuring carapace length. The water quality parameters observed included temperature, pH, salinity, and dissolved oxygen (DO). The research data were analyzed using a two-sample t-test assuming unequal variances at a 5% significance level.

RESULTS

The results showed that all main parameters in treatments P1 and P2 were not statistically significantly different ($p>0.05$). Nevertheless, treatment P2 showed a descriptively higher value than P1 for moulting frequency, while moulting time in P2 tended to be slightly faster. Several growth and survival parameters also showed a better tendency in P2. The research results are presented in Table 1.

Table 1. Growth, moulting, and survival of mud crab

Parameter	P1 (Beach Sand)	P2 (Beach Sand + Mangrove Leaves)	Description
Moulting frequency	0,375±0,517 times/day	0,500±0,534 times/day	Not significantly different
Number of moulting events	3 events	4 events	P2 descriptively higher
Moulting time	39,67±11,3 days	38,00±16,4 days	P2 descriptively slightly faster; not significantly different
Absolute weight gain	7,9±3,7 g	10,5±4,1 g	Not significantly different
Absolute length growth	0,36±0,18 cm	0,48±0,32 cm	Not significantly different
SGR	0,17±0,08%	0,23±0,09%	Not significantly different
Final SR	75%	87,5%	P2 descriptively higher
Mean SR	92,19±11,63%	96,88±6,25%	Not significantly different

The controlled rearing period for the test organisms was 45 days.

During the rearing period, 3 moulting events were recorded in P1, whereas 4 events were recorded in P2. The mean moulting frequency was 0.375±0.517 times/day in P1 and 0.500±0.534 times/day in P2. These results indicate that P2 had a descriptively higher moulting

frequency, but the difference was not statistically significant ($p>0.05$). Moulting in P1 occurred from day 28 to day 55, with a mean of 39.67±11.3 days, whereas moulting in P2 occurred from day 12 to day 57, with a mean of 38.00±16.4 days. The difference in mean moulting time was only approximately 1.67 days; therefore, P2 can be described as slightly faster, although it did not show a significant difference.

For the growth parameters, the mean absolute weight gain in P2 was 10.5±4.1 g, which was higher than the 7.9±3.7 g recorded in P1. The SGR value in P2 was also higher at 0.23±0.09%, whereas P1 was 0.17±0.08%. Conversely, the highest absolute length was obtained in P1 at 8.1±0.5 cm, whereas P2 was 7.7±0.2 cm. Final survival in P2 reached 87.5%, which was higher than the 75% recorded in P1.

WATER QUALITY

Table 2. Water quality during mud crab rearing

Parameter	Unit	Result	Threshold value (Rumondang et al., 2023)
Temperature	°C	28,4	23-35
pH	-	7,4	7-9
DO	mg/L	5,1	>5
Salinity	ppt	22	10-30

Water quality during the study remained within a range that supported mud crab survival, with a mean temperature of 28.4°C, pH of 7.4, salinity of 22 ppt, and DO of 5.1 mg/L.

DISCUSSION

Moulting Frequency

Based on the observations presented in Table 1, differences in rearing substrates produced descriptively different moulting-frequency responses in mud crab (*Scylla serrata*). In treatment P1, 3 moulting events occurred, whereas 4 events occurred in treatment P2. The mean moulting frequency was 0.375±0.517 times/day in P1 and 0.500±0.534 times/day in P2. These values indicate that beach sand with the addition of mangrove leaves tended to produce a higher moulting frequency than beach sand alone.

The tendency toward a higher moulting frequency in P2 was presumably associated with the presence of mangrove leaves as an additional substrate component that more closely resembled the natural habitat of mud crabs. Mangrove leaves can form protective spaces, reduce direct contact between the crabs and the bottom of the container, and minimize environmental disturbances during the pre- and post-moulting phases. During these phases, crabs are weak because the old exoskeleton has been shed and the new shell has not yet fully hardened. A more complex substrate can help crabs hide, thereby reducing physiological stress and allowing the available energy to be used for ecdysis and the formation of new body tissue.

However, the statistical test showed that moulting frequency did not differ significantly between P1 and P2 ($p>0.05$). This means that the addition of mangrove leaves to the beach sand medium cannot yet be stated to have a significant effect on mud crab moulting frequency. The absence of a statistical difference was presumably influenced by biological variation among individuals, including initial size, physiological condition, readiness of moulting hormones, feed consumption level, and adaptation ability. Therefore, P2 may be considered to show a better tendency, but the treatment effect was not strong enough to produce a significant difference.

Moulting Time

Based on the observations, the moulting time of mud crabs in treatments P1 and P2 varied among individuals during the rearing period. In treatment P1, moulting occurred from day 28

to day 55, with a mean moulting time of 39.67±11.3 days. In treatment P2, moulting occurred from day 12 to day 57, with a mean of 38.00±16.4 days. These results indicate that moulting time in the two treatments was relatively similar, although P2 descriptively had a slightly faster moulting time than P1.

The slightly faster moulting time in P2 was presumably associated with more supportive rearing-medium conditions. The addition of mangrove leaves can provide extra protection for crabs, particularly during the pre-moulting and post-moulting phases when the body remains soft. A bottom environment that more closely resembles a mangrove habitat has the potential to reduce stress and help crabs maintain a stable physiological condition. Physiological stability is important because the moulting process is governed by energy readiness, hormonal conditions, and the body's ability to form a new exoskeleton.

Nevertheless, the statistical test showed that moulting time did not differ significantly between P1 and P2 ($p>0.05$). The difference in mean moulting time of only approximately 1.67 days indicates that the addition of mangrove leaves did not produce a clear change in the acceleration of moulting. The nonsignificant difference may have resulted from variation in physiological readiness among individuals and the limited number of moulting events during the rearing period. Thus, P2 showed a tendency toward a slightly faster moulting time, but this was not strong enough to demonstrate a significant effect of substrate treatment on moulting acceleration.

Absolute Weight Gain and Specific Growth Rate (SGR)

The results showed that absolute weight gain and Specific Growth Rate (SGR) were descriptively higher in P2 than in P1. Absolute weight gain was 10.5±4.1 g in P2 and 7.9±3.7 g in P1. The SGR value was also higher in P2, at 0.23±0.09%, than in P1, at 0.17±0.08%. These data indicate that beach sand combined with mangrove leaves tended to better support the increase in mud crab body weight during rearing.

The higher absolute weight gain and SGR in P2 were closely associated with the higher moulting frequency in that treatment. In mud crabs, growth occurs discontinuously because the body is protected by a hard exoskeleton. Body-weight gain generally increases after moulting, when the new shell is still soft and the crab's body can expand through water absorption and the formation of new tissue. The more frequently a crab successfully passes through the moulting phase, the greater the opportunity for weight gain. In addition, the presence of mangrove leaves was presumed to help reduce stress, allowing more energy from feed to be used for growth rather than for stress responses or recovery of body condition.

Although P2 showed higher absolute weight and SGR values, the statistical test indicated that the difference between treatments was not significant ($P>0.05$). The SGR values in P1 and P2 were also not significantly different, with a p-value of 0.1830. This condition indicates that the substrate treatment did not have a significant effect on mud crab weight growth. Individual variation, including differences in initial weight, feed consumption level, adaptation ability, and moulting success, was presumed to account for the nonsignificant statistical results. Thus, P2 may be said to have a better tendency to increase weight growth and SGR, but statistically, the responses of the two treatments remained relatively similar.

Absolute Length Growth

Based on the observations, the highest descriptive absolute length growth was obtained in treatment P2, with a mean absolute length of 0.48±0.32 cm, whereas treatment P1 had a mean absolute length of 0.36±0.18 cm (Figure 4.8). These results indicate that the substrate used in P2 tended to produce a higher body-length value than P1. Length growth in mud crabs is closely related to changes in carapace size after moulting; therefore, the length response does not always correspond with body-weight growth.

The higher absolute length in P2 was presumed to have been influenced by the initial condition of the individuals and biological variation among the crabs. Crabs in P2 had a higher mean initial length, causing the final length value also to tend to be greater. Furthermore, increases in crab carapace length do not occur continuously but primarily after moulting. If individuals that moulted had a larger initial size or experienced more pronounced carapace expansion, the final length value could be higher even when the total moulting frequency was lower. Nova et al. (2023) reported that the use of different substrates can affect absolute weight gain but does not always produce the same response in absolute length growth.

The statistical test showed that the difference in absolute length between P1 and P2 was not significant, with a p-value of 0.1100 (P>0.05). This means that the two substrate treatments produced relatively similar responses in mud crab length growth. The absence of a significant difference may have been caused by variation in post-moulting time, the rate of carapace hardening, and differences in the initial size of each individual.

Survival Rate (SR)

The Survival Rate (SR) of mud crabs was higher in treatment P2 than in P1. At the end of the rearing period, the SR in P2 reached 87.5%, whereas P1 was 75%. The mean SR in P2 was also higher, at 96.88±6.25%, than in P1, at 92.19±11.63%. This condition indicates that the addition of mangrove leaves to the beach sand substrate tended to provide a rearing environment that better supported mud crab survival.

The tendency toward a higher SR in P2 was presumably associated with the presence of mangrove leaves, which can function as shelter and help reduce stress. Mud crabs are organisms that readily experience stress during adaptation and both before and after moulting because their bodies become soft and vulnerable. A more complex substrate can provide a sense of security, reduce disturbances, and help crabs maintain normal activity. In addition, the individual rearing system in crab boxes connected to the RAS also played a role in reducing the risk of cannibalism and maintaining stable water-quality conditions.

The statistical test showed that the difference in SR between P1 and P2 was not significant, with a p-value of 0.4736 (P>0.05). This indicates that the addition of mangrove leaves did not have a significant effect on mud crab survival. However, P2 still showed better descriptive results. The SR values in both treatments were still considered good because they were above 50%. Thus, both substrate types can still be used for mud crab rearing, but the combination of beach sand and mangrove leaves has better potential to support survival during rearing.

Water Quality Parameters of the Rearing Medium

Water quality is a major environmental factor affecting metabolism, growth, moulting, and the survival of mud crabs. Based on observations during rearing, water quality remained within a range that supported mud crab survival, with a mean temperature of 28.4°C, pH of 7.4, salinity of 22 ppt, and dissolved oxygen (DO) of 5.1 mg/L. These ranges were still consistent with the biological requirements of mud crabs and therefore did not constitute major limiting factors during the study.

A temperature of 28.4°C was presumed to support mud crab metabolic activity and moulting. A suitable temperature helps increase feeding activity, digestion, and the utilization of energy for growth. The pH value of 7.4 was also within a good tolerance range for mud crabs; therefore, the rearing medium was neither too acidic nor too alkaline. A salinity of 22 ppt was within a suitable range for mud crabs because this species can adapt to brackish and marine waters. Meanwhile, a DO value of 5.1 mg/L indicated sufficient oxygen availability for respiration, particularly during the energy-intensive moulting phase.

The stability of water quality during the study was presumably influenced by the use of a Recirculating Aquaculture System (RAS), which helped maintain circulation and the quality

of the rearing medium. Good water-quality conditions supported the crabs in remaining active, utilizing feed, moulting, and maintaining survival. Therefore, although substrate differences did not have a statistically significant effect, water quality within the optimal range was a supporting factor that allowed both treatments to produce relatively good growth, moulting, and SR.

CONCLUSION

Differences in rearing substrate type did not have a significant effect on the growth rate, moulting frequency, or moulting time of mud crab (*Scylla serrata*). Descriptively, beach sand with the addition of mangrove leaves (P2) showed a better tendency in moulting frequency, at 0.500±0.534 times/day, than P1, at 0.375±0.517 times/day. Moulting time in P2 also tended to be slightly faster, at 38.00±16.4 days, than in P1, at 39.67±11.3 days. However, these differences were not statistically significant; therefore, the combination of beach sand and mangrove leaves cannot yet be stated to be more effective than beach sand alone. Both substrate types can still support mud crab rearing, but further research with more replications and a longer rearing period is required so that the effects of substrate on moulting frequency and moulting time can be observed more clearly.

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