Fisheries Journal, 15 (3), 1101-1114 (2025)
http://doi.org/10.29303/jp.v15i3.1474

EFFECT OF FEEDING FREQUENCY ON THE GROWTH OF MUD CRABS (*SCYLLA SERRATA*) IN THE RECIRCULATING AQUACULTURE SYSTEM

Pengaruh Frekuensi Pemberian Pakan Terhadap Pertumbuhan Kepiting Bakau (*Scylla serrata*) Pada Recirculating Aquaculture System (RAS)

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(Received March 17th 2025; Accepted May 20th 2025)

ABSTRACT

Recirculating Aquaculture System (RAS) was chosen as an alternative for sustainable and low-impact mangrove crab cultivation. One of the main challenges in using RAS is determining the optimal feeding frequency. Inappropriate feeding can cause slow growth, increased mortality, and decreased water quality. This study aimed to analyze the effect of trash fish feeding frequency on the growth of mangrove crab (*Scylla serrata*) reared in RAS. The method used is an experimental method with a completely randomized design of 3 treatments and 4 replications. The research treatments tested were the frequency of feeding with FPP 01 once a day at 10 pm; FPP 02 twice a day at 10 pm and 5 pm; FPP 03 three times a day at 10 pm, 8 am and 5 pm. The parameters observed were survival, weight growth, carapace length growth, carapace width growth, specific growth rate and molting rate. The research data were analyzed using analysis of variance at a 95% significance level. The results showed that the frequency of feeding did not significantly affect the growth and survival of mud crabs in RAS. The frequency of feeding once is optimal to achieve maximum growth in mud crab cultivation using the RAS system with a survival rate of 100±0.00%, weight growth of 52.00±21.17 g, carapace length growth of 1.90±0.87 cm, carapace width growth of 1.60±0.70 cm, specific growth rate of 5.04±0.14%/day and molting rate of 67.00±0.58%.

Keywords: Frequency of Feeding, Growth, Recirculating Aquaculture System, *Scylla serrata*, Survival Rate

ABSTRAK

Recirculating Aquaculture System (RAS) dipilih sebagai alternatif untuk budidaya kepiting mangrove yang berkelanjutan dan berdampak rendah. Salah satu tantangan utama dalam menggunakan RAS adalah menentukan frekuensi pemberian makan yang optimal. Pemberian makan yang tidak tepat dapat menyebabkan pertumbuhan yang lambat, peningkatan mortalitas, dan penurunan kualitas air. Penelitian ini bertujuan untuk menganalisis pengaruh frekuensi pemberian makan ikan rongsokan terhadap pertumbuhan kepiting mangrove (*Scylla serrata*) yang dibudidayakan dalam sistem RAS. Metode yang digunakan adalah metode eksperimen dengan desain acak lengkap dengan 3 perlakuan dan 4 ulangan. Perlakuan yang diuji dalam penelitian ini adalah frekuensi pemberian makan dengan FPP 01 sekali sehari pada pukul 10 malam; FPP 02 dua kali sehari pada pukul 10 malam dan 5 sore; FPP 03 tiga kali sehari pada pukul 10 malam, 8 pagi, dan 5 sore. Parameter yang diamati meliputi kelangsungan hidup, pertumbuhan berat, pertumbuhan panjang karapas, pertumbuhan lebar karapas, laju pertumbuhan spesifik, dan tingkat molting. Data penelitian dianalisis menggunakan analisis variansi dengan tingkat signifikansi 95%. Hasil penelitian menunjukkan bahwa frekuensi pemberian makan tidak berpengaruh signifikan terhadap pertumbuhan dan kelangsungan hidup kepiting mud crab dalam sistem RAS. Frekuensi pemberian makan sekali sehari adalah yang optimal untuk mencapai pertumbuhan maksimal dalam budidaya kepiting mangrove menggunakan sistem RAS dengan tingkat kelangsungan hidup 100±0,00%, pertumbuhan berat 52,00±21,17 g, pertumbuhan panjang karapas 1,90±0,87 cm, pertumbuhan lebar karapas 1,60±0,70 cm, laju pertumbuhan spesifik 5.04±0.14%/hari, dan tingkat molting 67,00±0,58%. Kata Kunci: Frekuensi Pemberian Makan, Pertumbuhan, Sistem Akuakultur Sirkulasi Ulang, *Scylla serrata*, Tingkat Kelangsungan Hidup

Kata Kunci: Frekuensi Pemberian Pakan, Pertumbuhan, Sistem Akuakultur Resirkulasi, Scylla serrata, Tingkat Kelangsungan Hidup

INTRODUCTION

One of the organisms that are abundant in the mangrove ecosystem is mangrove crab. According to Sadinar *et al*. (2013) mangrove crab is one of the aquatic biotas that has high economic value, as well as a promising fishery commodity to be developed through cultivation. Crabs are very popular not only because of their delicious taste but also because they are rich in nutrients that are good for the body (Herliyani and Zamdial, 2015). The increase in demand has an impact on the increase in fishing in nature, considering that the fulfillment of demand for mangrove crab is dominated by catches from nature (Herliyani and Zamdial, 2015). Excessive exploitation rates can result in a decline in the population of mangrove crabs in nature. The decline in the population and production of mangrove crabs is also caused by the reduction in the area of mangroves, habitat destruction, pollution and the problem of overfishing. The potential of mangrove crabs which have high economic value in the domestic and international markets has made fishermen start cultivating mangrove crabs in ponds. In addition, cultivation can increase the production of mangrove crabs to meet the demand of the domestic and international markets (Mutaminah and Wahyudin, 2023).

One of the technologies being developed to achieve sustainable aquaculture while maintaining environmental carrying capacity is the Recirculating Aquaculture System (RAS) technology. RAS is one of the solutions in sustainable cultivation that can produce continuous production while minimizing its impact on the environment (Jacinda *et al*., 2021). According to Jacinda *et al*., (2021) the quality of water is an important requirement that can affect the survival of the development, growth and production levels of aquatic biota. A good environment is essential for the survival of aquatic organisms.

Feeding patterns must be adjusted to environmental conditions and the biological needs of the crab. Feeding patterns in mangrove crabs can vary depending on the growth phase, environmental conditions, and cultivation objectives (Sayuti *et al*., 2012). The frequency of feeding in mangrove crabs is very important to ensure optimal growth, good health, and successful reproduction. The frequency of feeding is very important so that farmers or researchers can find out the efficient feeding time (Sihite *et al*., 2020). This study was to analyze the effect of giving trash fish with different frequencies on the growth of Mangrove Crabs (*Scylla serrata*) in the Recirculating Aquaculture System (RAS). Trash fish refers to types of fish that typically consist of scraps or pieces of seafood, such as small fish, shrimp, and other parts not used for human consumption.

METHOD

Time and Place

This research was conducted from May to July 2024 at the UPTD of the Marine and Brackish Water Aquaculture Center (BPBALP) Sungai Nipah, Pesisir Selatan Regency, West Sumatra, Indonesia.

Materials and Tools

The materials and tools used in this study were mangrove crab (Sycilla serrata) as the object of research. Maco fish as feed for mangrove crabs during the study with a provision of 5% of biomass/day. Research tools in the form of individual fiber tubs measuring 2x1x0.5 m, water pumps, piping installations, dacron, protein skimmer, bio foam, UV lamps, biobal rambutan, and kaldness, these tools are used for the aquaculture recirculation system. Crab house box measuring 40x36x18 as a place to maintain mangrove crabs during the study. Aerator pump used to supply oxygen in the research container, scales as a measuring tool for the weight of mangrove crabs during sampling. Thermometer used to measure water temperature, pH meter to measure water pH and refractometer used to measure salinity. These tools are used to measure water quality during the study.

Method

The method used is an experimental method with a completely randomized design (CRD) of 3 treatments and 3 replications. The research treatment tested was the frequency of feeding. FPP 01 once a day at 10 pm; FPP 02 twice a day at 5 pm and 10 pm; FPP 03 three times a day at 8 am, 5 pm and 10 pm. Determination of feeding time as a treatment refers to Hartanti *et al*., (2023).

Procedure

Prepare the Container The container preparation stage in mangrove crab cultivation research or similar studies involves several important steps to ensure the availability of tools and materials before use, such as a fiber tub for the RAS container and 27 crabs house boxes in 1 crab apartment unit. Before use, the container must be cleaned and sterilized first to prevent contamination by pathogenic. microorganisms and chemicals that can affect the results of research on test animals. Sterilization of the tub is carried out using chlorine at a concentration of 150 ppm and left for 24 hours, then rinsed with water until clean.

Distribution of Mud Crabs

The mud crabs came from the UPTD of the Marine and Brackish Water Aquaculture Center (BPBALP) Sungai Nipah, Pesisir Selatan Regency, West Sumatra, Indonesia. The length of the mud crabs used was ± 7-9 cm, width ± 5- 7 cm and weight ± 100-150 g.

Preparation of Fresh Fish as Feed

The trash fish that will be given to the mangrove crabs have been cleaned and cut according to the size of the crab, which aims to make it easier to consume and facilitate digestion for the crabs. The feeding frequency is adjusted according to the research treatment. The trash fish feed is provided at 5% of the crab's body weight per day.

Maintenance and Observation

The mangrove crabs were distributed at a rate of one crab per box within a multi-level "apartment" structure, which is specifically designed to cultivate mangrove crabs in a controlled environment. A total of 9 crabs were used in the study, divided into 3 treatments with 3 repetitions each.. Feeding began at night, morning and afternoon feeding times were set for 10 p.m., 8 a.m., and 5 p.m., maintaining a 10-hour interval between each feeding. Since mangrove crabs are nocturnal, the feeding schedule was initiated at night to align with their natural behavior. Mangrove crab maintenance was conducted for 60 days with measurements of weight, length, and width taken every 10 days.

Observation Parameters

Survival rate (SR)

The survival rate of crabs can be calculated using the formula according to Effendi. (2002), namely:

$$SR = Nt/No \times 100\%$$

Description:
SR = Survival rate (%)
Nt = Number of crabs at the end of the study
No = Number of crabs at the beginning of the study

Weight Growth

Weight Growth is the weight growth of organism in a certain time interval, measured by calculating the difference between the initial weight and the final weight. Crab weight growth is calculated using the Effendi formula. (2002):

$$Wm = Wt - Wo$$

Description:
Wm = Absolute crab weight growth (g)
Wt = Average final crab weight (g)
Wo = Average initial crab weight (g)

Carapace Length Growth

The increase in body length is the difference between the length of the carapace at the end of the study and the length of the body at the beginning of the study. The increase in crab length is calculated using the Effendi formula. (2002):

$$Pm = Lt - Lo$$

Description
Pm = absolute increase in carapace length (cm)
Lt = average final carapace length (cm)
Lo = average initial carapace length (cm)

Carapace Width Growth

The formula for calculating carapace width growth can be calculated using the formula according to Effendi. (2002):

$$L = Lt - Lo$$

Description
L = carapace width growth (cm)
Lt = average carapace width at the end of the maintenance period (cm)Lo = average carapace width at the beginning of maintenance (cm)

Specific Growth Rate

The formula for calculating the specific growth rate (SGR) according to Mulqan *et al*., (2017) is:

$$SGR = ((Ln\ Wt - Ln\ Wo))/t$$

Description
Ln Wt = logarithm e (base e) of the average weight at the end of maintenance (g)
Ln Wo = logarithm e (base e) of the average weight at the beginning of maintenance (g)
t = maintenance period (days)

Molting Rate

Molting rate is an important aspect to consider. It refers to the number of crabs that undergo molting during a specific period of time. The molting rate can vary depending on several factors, such as age, species, environmental conditions, and the quality of the feed provided. Younger crabs typically have a higher molting rate compared to adult crabs, as they are in a faster growth phase.The molting frequency can vary depending on the type of crab, maintenance conditions, and environmental conditions. The molting rate is calculated using the Modified formula from Effendi. (2002):

$$TM = Mt/Mo \times 100\%$$

Description
TM = Molting rate of Mangrove Crabs
Mt = Number of Mangrove crabs that molting
Mo = Number of Mangrove Crabs that are maintained

Water Quality

Measurement of water quality parameters involves monitoring temperature, dissolved oxygen (DO), pH, and salinity. The condition of the maintenance media was is observed twice a day, in the morning and evening.

Data Analysis

Data obtained from observations were analyzed using analysis of variance (ANOVA) at a 95% confidence level. To assess differences between treatments, further testing will be carried out using the Duncan New Multiple Range Test (DNMRT).

RESULT

Survival of Mud Crab (*Scylla serrata*)

The results of the variance analysis of mangrove crab survival showed no significant effect (P>0.05) of feeding frequency on survival. The average survival rates from each treatment can be seen in Table 1.

Table 1. Survival Rate of Mud Crab (*Scylla serrata*)

Treatment	SR (%)
FPP 01	100±0.00[a]
FPP 02	100±0.00[a]
FPP 03	33.33±57.73[a]

Note: The same superscript indicates no significant difference (P>0.05).

Absolute Weight Growth of Mud Crab (*Scylla serrata*)

Variance analysis indicated that different feeding frequencies did not significantly affect the weight growth of the mangrove crabs (P>0.05). The absolute weight growth from each treatment can be seen in Table 2**.**

Table 2. Absolute weight growth of Mud Crab *(Scylla serrata)*

Treatment	Weight Growth (g)
FPP 01	52.00±21.17 [a]
FPP 02	41.00±23.64 [a]
FPP 03	18.00±10.40 [a]

Note: The same superscript indicates no significant difference (P>0.05).

Growth of Mud Crab *(Scylla serrata)* Carapace Length

Based on the results of the variance analysis, it was shown that the provision of trash fish with different frequencies in the recirculating aquaculture system (RAS) did not have a significant effect on the growth of the carapace length of mangrove crabs (P>0.05). The growth of Mud Crab carapace length from each treatment can be seen in table 3.

Table 3. Growth in carapace length of mud crab *(Scylla serrata)* during the study.

Treatment	Growth length (cm)
FPP 01	1.90±0.87[a]
FPP 02	0.93±0.65[a]
FPP 03	0.60±0.35[a]

Note: The same superscript indicates no significant difference (P>0.05).

Growth of Mud Crab *(Scylla serrata)* Carapace Width

Based on the results of the variance analysis, it showed that the provision of trash fish with different frequencies in the recirculating aquaculture system (ras) did not have a significant effect on the growth of the carapace length of mangrove crabs (P>0.05). The growth of Mud Crab carapace width from each treatment can be seen in table 4.

Table 4. Growth in carapace length of mud crab *(Scylla serrata)*

Treatment	Width length (cm)
FPP 01	1.60±0.70[a]
FPP 02	1.17±0.66[a]
FPP 03	0.80±0.46[a]

Note: The same superscript indicates no significant difference (P>0.05).

Specific Growth Rate (SGR) of Mud Crab *(Scylla serrata)*

The specific growth rate of Mud Crab *(Scylla serrata)* from each treatment can be seen in table 5.

Table 5. Specific Growth Rate (SGR) of Mud Crab *(Scylla serrata)*

Treatment	Specific Growth Rate (%/day)
FPP 01	5.04±0.14[a]
FPP 02	4.92±0.18[a]
FPP 03	4.69±2.71[a]

Note: The same superscript indicates no significant difference (P>0.05).

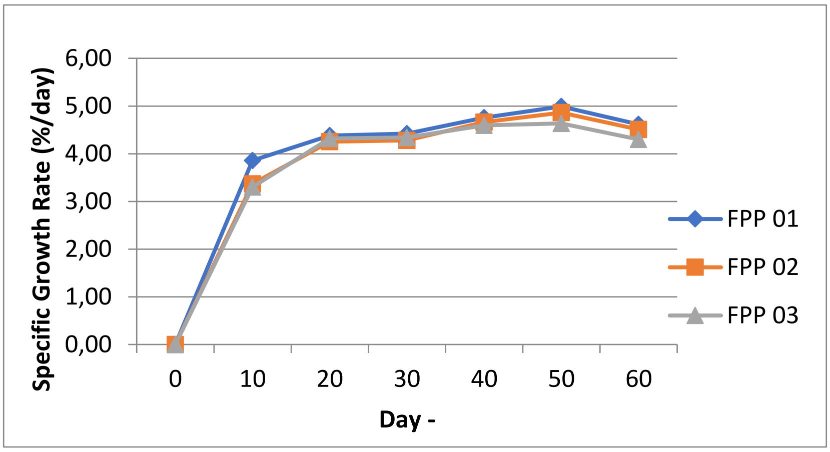

Figure 1. Specific growth rate (SGR) graph of mangrove crabs

Molting Frequency of Mud Crab (*Scylla serrata*)

From table 6 shows the frequency of molting of mangrove crabs from each treatment get the results of each treatment. Based on table 6 it can be seen that the frequency of molting in treatments FPP 01 and FPP 02 0.67 ± 0.58 for 60 days of maintenance is the best with the number of molting mangrove crabs is 2 and both 1 time in treatments FPP 01.1, FPP 01.3 and FPP 021, FPP 02.3. In treatment C there was never molting.

Table 6. Molting Rate of Mud Crab *(Scylla serrata)*

Treatment	Molting Rate (%)
FPP 01	66.77±0.58[a]
FPP 02	66.77±0.58[a]
FPP 03	0.00±0.00

Note: The same superscript letters behind the mean value indicate no significant difference (P>0.05).

Water Quality

Water quality is crucial for the physiological condition of mangrove crabs. The recirculating aquaculture system effectively improves water quality, reducing ammonia concentration. The water quality during the study can be seen in Table 7.

Table 7. Water quality of mud crabs *(Scylla serrata)* during the study.

Parameters	Beginning	Ending
Salinity (ppt)	20	20
Temperature (ºC)	27,8	26,3
pH	6,82	6,88
DO (mg/l)	5,06	4,17

DISCUSSION

Survival of Mud Crab *(Scylla serrata)*

The results of the analysis of mangrove crab variance showed that the frequency of feeding did not have a significant effect (P>0.05) on the survival of mangrove crabs. The average survival data of Mud Crab from each treatment can be seen in table 1 Over the 60-day observation period, the survival rate of mangrove crabs showed no significant differences, suggesting that the conditions were favorable. The low survival rate in treatment C is suspected to be due to the mismatch between the maintenance environment and the crabs' natural habitat, as well as stress from the inability to adapt to the new environment, which may lead to a decrease in appetite (Purnawarman *et al*., 2021). Providing feed in the right amount allows crabs to grow and develop optimally (Ningsih and Affandi, 2023). Well-digested feed will provide an energy supply used for maintenance and body activities, so that excess energy can be used for growth (Rahmawan *et al*., 2014). According to Subandiyono and Hastuti, (2011), well-digested feed will provide an energy supply used for maintenance and body activities, and excess energy is used for growth. In addition, mangrove crabs are believed to be able to utilize feed more efficiently.

Absolute Weight Growth of Mud Crab *(Scylla serrata)*

Based on table 2, it can be seen that treatment FPP 01 with an absolute average weight (52.00±21.17 gr) is the best, followed by treatment FPP 02 (41.00±23.64 gr) and the lowest is treatment FPP 03 (18.00±10.40 gr). According to Tahe *et al*., (2017), the duration of maintenance has a significant effect on growth. Treatment with a feeding frequency of three times a day in treatment FPP 03 resulted in lower weight growth compared to other treatments. It is suspected that when given at 08.00 WIB, mangrove crabs tend not to eat it because mangrove crabs are nocturnal animals, according to the statement of Pasaribu *et al*., (2015) that mangrove crabs are animals that are active at night. The duration of feeding does not match the rate of gastric emptying of mangrove crabs causing less feed consumption, due to the limited availability of feed in the experimental container, the limited availability of feed in the experimental container can restrict the crabs' ability to meet their nutritional needs optimally, thereby affecting their growth and feed efficiency (Annisa *et al*., 2024). Providing feed in the right amount allows crabs to grow and develop optimally (Ningsih and Affandi, 2023). The highest absolute weight growth in mangrove crabs was found in treatment FPP 01 with a feeding frequency of once a day. This is thought to be due to the high level of feed digestibility in the treatment and the crab's activity which tends to be at night. According to Subandiyono and Hastuti, (2011), well-digested feed will provide an energy supply used for maintenance and body activity, and excess energy is used for growth. In addition, it is thought that mangrove crabs can utilize feed better.

Growth of Mud Crab *(Scylla serrata)* Carapace Length

Based on table 3, it can be seen that treatment FPP 01 with an average carapace length (1.90±0.87 cm) was the best unit, followed by treatment FPP 02 (0.93±0.65 cm) and the lowest was treatment FPP 03 (0.60±0.35 cm). The decrease in treatment FPP 03 also occurred due to death in FPP 03 replication 2 , this is thought to be due to the high level of stress in mangrove crabs and the large amount of leftover feed in the crab house box in treatments FPP 03.2 and FPP 03.3. The difference in feed management given at 08.00 WIB caused feed sedimentation. This was obtained because mangrove crabs did not eat feed in the morning. Crabs are nocturnal animals that forage and are active at night, this is in accordance with the statement of Ningsih and Affandi (2023) that providing feed with management that is appropriate for mangrove crabs can foster optimal growth. Optimal feeding frequency ensures that mangrove crabs get the essential nutrients needed for growth, including protein, calcium, and phosphorus which are important for carapace formation. Adequate nutrition supports the process of forming hard tissue (exoskeleton), including carapace (Haryati *et al*., 2018). If the timing of feeding is not right, the crabs do not get enough energy to support carapace growth, which can slow or even stop the growth of carapace length. According to Lubis *et al*., (2023) the energy needs of a species should be met by non-protein nutrients such as fat and carbohydrates. Inadequate feeding frequency can affect the molting cycle and slow down carapace growth in mud crabs. A feeding frequency that is too low may cause periodic starvation, hindering the accumulation of energy and nutrients necessary for molting and growth (Kanna *et al*., 2021). Conversely, excessive feeding frequency can reduce feed efficiency due to unused surplus feed. Therefore, an appropriate feeding frequency is crucial to support carapace length growth efficiently and sustainably.

Growth of Mud Crab *(Scylla serrata)* Carapace Width

Based on table 4, it can be seen that treatment FPP 01 with an average carapace length of 1.60±0.70 cm is the best, followed by treatment FPP 02 1.17±0.66 cm and the lowest treatment FPP 03 0.80±0.46 cm. Feeding frequency is a crucial factor that does not significantly affect the growth of carapace width of mud crabs in recirculating aquaculture systems (RAS), this indicates that mud crabs have the ability to adapt to different feeding schedules, provided that the quantity and quality of the feed meet their nutritional needs. Furthermore, the stability of water quality parameters in the RAS system helps maintain the physiological condition of the crabs, making feeding frequency a less critical factor in supporting carapace width growth. In crab farming, carapace width is an important indicator of individual growth and health. Feeding at the right frequency ensures that crabs receive essential nutrients, including protein, fat, and minerals such as calcium, consistently (Dayal *et al*., 2019). These nutrients are essential for the process of forming a strong and wide carapace. When these nutrients are optimally available, crabs can focus their protein use on the synthesis of new tissues, including carapace, rather than using it as an energy source. Protein, along with minerals such as calcium and phosphorus, plays a key role in strengthening the carapace structure and accelerating the regeneration of hard tissues after molting. Carapace growth, including carapace width, occurs mainly through the molting process. Proses ini membutuhkan energi yang tinggi dan nutrisi yang memadai untuk memastikan bahwa karapas yang baru terbentuk memiliki struktur yang kokoh dan ukuran yang optimal. Jika kebutuhan energi dan nutrisi ini tidak terpenuhi, proses molting dapat terhambat atau menghasilkan karapas yang tidak sempurna, yang pada akhirnya memengaruhi pertumbuhan keseluruhan kepiting (Karim *et al*., 2019).

The right feeding frequency helps prepare crabs for molting by providing sufficient energy and nutrients (Tulangaow *et al*., 2019). If the required energy is available from non-protein nutrients such as fat and carbohydrates, protein can be focused on the growth of new tissues, including carapace. Consistent and appropriate feeding frequency encourages more frequent molting, allowing faster and wider carapace growth. According to Zhao *et al*., (2015), the optimal feeding frequency for the growth of carapace width of mangrove crabs in RAS does not seem to be greatly influenced by variations in frequency, but rather by the composition of nutrients in the feed. Feed with a protein content of 32-40% and lipids of 6% is the most effective for increasing carapace width.

Specific Growth Rate (SGR) of Mud Crab *(Scylla serrata)*

Based on the results of the variance analysis, it was shown that the provision of trash fish with different frequencies in the recirculating aquaculture system (ras) did not have a significant effect on the growth of the carapace width of mangrove crabs (P>0.05). Based on table 5, it can be seen average SGR during 60 days of maintenance in treatment FPP 01 (4.55±0.14%/day) was the best, followed by treatment FPP 02 (4.45±0.18 %/day) and the lowest was treatment FPP 03 (4.24±2.71 %/day). Daily growth rate indicates the daily percentage of mangrove crab growth. This value is obtained from the percentage of the previous value heavy growth. The average SGR for each sampling (10 days of growth) in treatment FPP 01 was 3.86 %/day, FPP 02 3.37 %/day, and FPP 03 3.30 %/day. While SGR is the daily weight gain value starting from the initial and final weight measurements. Environmental factors that influence are very diverse, one of which is the frequency of feeding. In treatments FPP 01, 02 and 03 there was a stable increase for 50 days of maintenance, on the 30-50th day of maintenance there was a high increase in treatments FPP 01 and FPP 02, the high increase in SGR was influenced by the growth of crabs after molting, thus affecting the weight, width and length which could reach 20-25% growth from the previous weight (Kanna *et al*., 2021). While on the 60th day there was a decrease because in treatments FPP 01 and FPP 02 the growth of crabs was not as much as when the crabs were ready to molt, and in treatment FPP 03 the decrease in growth occurred due to death in repeats FPP 03.2 and FPP 03.3.

The right feeding frequency ensures that crabs receive nutrients consistently. Stable nutrition is essential to support optimal metabolic processes, which directly contribute to specific growth rates, If the intake of nutrients, such as protein, fats, and carbohydrates, is well-maintained and balanced, the crab's metabolism will function efficiently, enabling rapid and healthy growth. The availability of feed and the ability of lobsters to utilize or digest feed will determine lobster growth (Hartanti *et al*., 2023). Feeding at inappropriate times can cause fluctuations in energy and nutrient availability, thereby inhibiting growth and reducing SGR. Conversely, regular feeding frequencies allow crabs to utilize nutrients efficiently, thereby increasing SGR (Karim *et al*., 2019). According to Thesiana & Pamungkas (2015), regular feeding frequencies also help reduce stress and competition between individuals in RAS systems, which usually have high population densities. By reducing stress levels through consistent feeding, crabs can allocate more energy to growth processes rather than to stress response mechanisms, which ultimately increases SGR. Physiological stress in animals, including crabs, triggers the activation of the stress response system, which uses energy to cope with threats or pressures, such as the release of corticosteroid hormones (Sadoul and Vijayan, 2016). These hormones regulate various body processes focused on survival, including an increase in metabolism to provide quick energy. However, the energy used for this stress response reduces the amount of energy available for other processes, including growth. With consistent feeding, crabs can avoid fluctuations in stress levels that typically occur due to hunger or uncertainty in feed availability. Stable feeding ensures sufficient energy, allowing the crab's body to focus more on anabolic processes, such as protein synthesis and the formation of new tissues, which are essential for growth (He *et al*., 2023). As a result, more energy can be allocated to growth (particularly in carapace size increase) rather than to stress response mechanisms. This, in turn, will improve the Specific Growth Rate (SGR), which measures the efficiency of converting energy into new body mass.

Molting Frequency of Mud Crab (*Scylla serrata*)

Based on the results of the analysis of variance showed that the effect of giving trash fish with different frequencies on the growth of mangrove crabs in the recirculating aquaculture system did not have a significant effect on the frequency of molting mangrove crabs (P> 0.05). According to Pattirane *et al*., (2022) showed that the frequency of feeding can affect the frequency of mangrove crab molting. The right frequency of feeding can increase the frequency of molting, thereby increasing the growth rate and production of mangrove crabs. The molting process is highly dependent on the availability of sufficient energy. If crabs get feed with a high enough frequency, they can store the energy needed for the molting process (Nguyen *et al*., 2014). Low or inadequate feeding frequency can cause energy deficiency, which can delay or inhibit the molting process, because the crab's body does not have enough energy reserves to go through the process. In crabs that molt, there is an increase in weight of 30-50 grams. This is in accordance with the statement of Hasnidar & Tamsil (2023) that crabs with an average initial weight of 80-100 grams, achieve a weight increase of around 20-25%. The molting time of mangrove crabs can vary depending on the size of the crab. According to Hastuti *et al*., (2019), the molting time for crabs measuring 80-100 grams is around 13-15 days, while for crabs measuring 100-120 grams it is around 15-17 days.

Water Quality

Water quality has a significant influence on the physiological condition of mangrove crabs, water as the environment where crabs live must support their life and growth. The principle of the recirculation system is to improve water quality, such as reducing ammonia concentration. Pasi *et al*., (2021) stated that the recirculation system with a filter function mechanically to purify water and biologically to neutralize toxic ammonia compounds into nitrates. Purnawarman *et al*., (2021) added that the use of biofilters can remove around 95-98% of ammonia, both with organic and inorganic materials. In addition to improving water quality, the recirculation system is also able to filter particles that can interfere with the life of the cultivar. The quality of the water produced from the recirculation system can be analyzed to evaluate its effectiveness. The salinity of the maintenance media is closely related to the level of energy requirements in the osmoregulation process carried out by crabs to balance the fluids in their bodies with the fluids in their environment. In measuring the salt content (salinity) in the mangrove crab maintenance media, the average salinity results were obtained at 20 ppt, which is where this salinity is suitable for the growth of mangrove crabs. This statement is in accordance with Aulia and Diamahesa (2024) that the optimal salinity for mangrove crab metabolism is 25 ppt. According to Tulangaow *et al*. (2019) crabs can live at a salinity of 9–39%, but the ideal salinity for crab growth is 30-31%. Suboptimal salinity variations can disrupt osmoregulation, affect the utilization of feed energy, synthesis of metabolic materials and crab immunity.

Temperature significantly impacts the activity, appetite, oxygen consumption, and metabolic rate of crustaceans (Purnawarman *et al*., 2021). Optimal temperature for mangrove crabs ranges from 25-35ºC, with 29ºC showing the highest survival rate of 83.33% (Hastuti *et al*., 2019). During the study, the average temperature was 26.7ºC, which is ideal for cultivation. The pH level during the study averaged 6.85, which is not optimal, as it falls below the recommended range of 7.5-8.5 for optimal growth (Aulia and Diamahesa, 2024). A pH of 6-6.8 is acceptable for survival but not optimal for growth (Hastuti *et al*., 2016). Dissolved oxygen (DO) during the study averaged 4.8 mg/L, which supports crab growth, as mangrove crabs thrive in environments with 2.65-4.00 mg/L but require >5 mg/L for optimal growth (Aulia and Diamahesa, 2024; Hastuti *et al*., 2017). A DO of 4 ppm is considered the minimum for viable life in aquatic environments (Avianto *et al*., 2021). Based on the results of the study for 60 days, it can be concluded that the frequency of feeding does not have a significant effect on the growth and survival of mud crab *(Scylla serrata)* in the Recirculating Aquaculture System (RAS). The best results of this study were in treatment FPP 01 with feeding once a day at 10 pm. The average SR value (100±0.00%), weight growth (52.00 ± 21.17 gr), Carapace length growth (1.90 ± 0.87 cm), Carapace width growth (1.60 ± 0.70 cm), specific growth rate (SGR) (5.04 ± 0.14) and molting rate (0.67 ± 0.58).

CONCLUSION

Based on the results of the study for 60 days, it can be concluded that the frequency of feeding does not have a significant effect on the growth and survival of mud crab *(Scylla serrata)* in the Recirculating Aquaculture System (RAS). The best results of this study were in treatment FPP 01 with feeding once a day at 10 pm. The average SR value (100±0.00%), weight growth (52.00 ± 21.17 gr), Carapace length growth (1.90 ± 0.87 cm), Carapace width growth (1.60 ± 0.70 cm), specific growth rate (SGR) (5.04 ± 0.14) and molting rate (0.67 ± 0.58).

ACKNOWLWDGEMENT

The author would like to express sincere gratitude to all parties who contributed to the completion of this research. Special thanks are extended to colleagues and field assistants for their valuable support during data collection and analysis. Appreciation is also given to the academic and technical staff at UPTD of the Marine and Brackish Water Aquaculture Center (BPBALP) Sungai Nipah, Pesisir Selatan Regency, West Sumatra, Indonesia for providing the necessary facilities and guidance throughout this study.

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