

EFFECT OF STOCKING DENSITY ON THE GROWTH PERFORMANCE AND SURVIVAL OF GREEN LOBSTER PUERULUS (PENULIRUS HOMARUS)

Rita Rostika¹, Lim Leong Seng², Rinaldo Nurfaizi³, Bayu Priyambodo⁴, Irfan Zidni⁵

^{1,3,5}*Fakultas Perikanan dan Ilmu Kelautan Universitas Padjadjaran, Indonesia*

²*Institut Penelitian Kelautan Kalimantan, Universitas Malaysia Sabah, Indonesia*

⁴*Kementerian Kelautan dan Perikanan, Indonesia*

putrisd@gmail.com

ABSTRACT

This research aims to discover the growth rate and survival of puerulus green lobster (*Panulirus homarus*) kept in varied densities in controlled containers. This research was conducted from August 2022 through September 2022 for 60 days at Koperasi Samudera Bahari Utama, Girimukti Village, Pelabuhanratu, Sukabumi District, West Java. The method used in this research was Completely Randomized Design (CRD) with 5 treatments and 3 repetitions. These treatments were, A (density 10 lobsters/container), B (density 15 lobsters/container), C (density 20 lobsters/container), D (density 25 lobsters/container), and E (density 30 lobsters/container). The effect of each treatment was tested using the f-test in analysis of variance (ANOVA) at 5% test interval. If a significant difference was found, it would be followed by Duncan's multiple range test. The parameters observed in this research were Survival Rate (SR), Feeding Efficiency (FE), Growth (GR) and water quality in the research media. From the research analysis, it was found that the highest parameters for Puerulus's survival rate was in density A (10 lobsters) at 100%, for feeding efficiency (EPP) was in density A (10 lobsters) at the highest value of 5.07%, and for weight growth (WG), length growth (LG) during the research was in density A (10 lobsters) at a value of 2.4 gram. The oxygen content obtained from this research had a mean value of 6.2 mg/L. And the pH value was 7.66. The temperature was kept at 27-30°C range and the good salinity for lobster growth was at 25–28 ppt range.

Keywords: *feed, green lobster, growth performance, stocking density, survival rate*

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INTRODUCTION

Aquaculture is one among the fastest developing economic sectors in the world. Presently, Asia contributes about 90% of the total aquaculture production globally (Arumugam et al., 2020). Spiny lobsters are among the world's most valuable seafood as it is driven by the strong demand and limited global supply. Lobster farming relies heavily on wild-caught seafood as the major source of nutrition (Nankervis & Jones, 2022). Lobster (*Panulirus* sp) or seawater lobster is one of export commodities of Indonesia's fisheries sub-sector and constitutes an important part of the country's shrimp fishery industry. Lobster (*Panulirus* sp) is a potential commodity with economic value and its demand for both domestic and export markets keeps on increasing (Pratiwi, 2018). Hong Kong, Japan, China, Taiwan, and some countries in Europe are where Indonesia's lobsters are exported to (Trijoko & Nurcholis 2018). It is important to develop this commodity further considering its high trade value and potential. Indonesia is currently ranked at 17th place as the top lobster exporting countries in the world. At ASEAN level, Indonesia is the main country that exports lobsters.

The high demand for its seeds has shifted the preference to the sales of wild-caught directly than the expanded ones. The lobster seeds caught by fishermen are only valued around Rp 10.000 to Rp 15.000 per lobster, yet in Vietnam the price is up to Rp139 thousand per lobster

(Hidayatullah, 2020). This is considered highly profitable for those working as fry catchers and collectors (Hilal, 2016). At the same time, the price at customer level is generally higher than that of other seafoods. In Jakarta and Bali, a lobster of customer size >500g worths \$65-80 or around Rp985,551- Rp1,212,936. In Vietnam, a lobster of similar size is sold for higher price, starting from \$90 to \$120 or around Rp1,364,553-Rp1,819,404 (Hoc & Jones, 2014).

The success rate of rearing lobster seeds in Indonesia is still low, especially that at puerulus level until it reaches juvenile at a survival rate of only around 20%-50% (Shanks et al., 2014). Most lobster farmers use fresh food that is easily available such as trash fish, anchovies, freshwater shrimp and squid. The causes are cannibalism, disease, transportation, water quality and rearing management that has not met the standards. Cannibalism can occur when the density is too high in the cultivation system.

Cokrowati et al. 2013 examined research on post puerulus *Penulirus homarus* density with a single factor, namely stocking density with a density of 20 fish/m², 40 lobsters/m², 60 lobster/m², and 80 lobster/m². Parameters that observed was the specific growth and survival (SR) of post. The results showed that the treatment provided differences in stocking density effect ($P < 0.05$) on specific growth and survival (SR) post puerulus. The highest SGR and SR values are found at density 20 peulurus/m² of 2.15% with an SR value of 75%. Johnston (2006) stated that the growth and survival of western rock lobster, post-pueruli *Panulirus cygnus* (mean 2.14 ± 0.07 g, 50 and 100 m⁻², survival rate of lobsters held at the lower densities (90–95%) was significantly greater than for lobsters held at higher densities (post-pueruli = 78%).

Stocking density is a critical factor affecting performance of aquatic organisms in culture, however, its influence on energy utilisation has rarely been considered. Energy partitioning is particularly important for spiny lobster phyllosoma, which must accumulate sufficient energy reserves for metamorphosis and the non-feeding puerulus stage. The current study is the first to examine the energetics of spiny lobsters throughout the entire phyllosoma phase and determined the physiological influence of density. Growth and development, oxygen consumption and ammonia-N excretion rates were measured in *Sagmariasus verreauxi* phyllosoma that were cultured at High Density (HD) and Low Density (LD) from hatch to puerulus. Phyllosoma growth and development was more advanced in LD phyllosoma after 108 day in culture and mass of LD instar 17 phyllosoma was greater. There were no differences in routine metabolic rate (Rr) and ammonia-N excretion of phyllosoma between densities. However, the O:N ratio decreased in final instar phyllosoma demonstrating a shift towards higher protein catabolism. Routine metabolic rate also increased in late stage phyllosoma, possibly due to higher energy requirements in preparation for metamorphosis and increased swimming activity. The Rr of spiny lobster larvae was significantly lower than that of other crustacean larvae, which may be a characteristic of their extended larval phase, slower growth rate, and larger body size. The study demonstrated late stage phyllosoma have higher weight specific energy requirements than the preceding larval stages and exhibit a metabolic shift towards protein catabolism, suggesting an increased importance of storing lipid as an energy reserve for the puerulus stage.

The survival rate of post-puerulus green lobster is affected by some factors, namely the moulting frequency, lobster density, shelter availability, and water quality.

Based on this fact, this research was conducted to discover the effect of different densities on the growth and survival rates of puerulus green lobster in controlled containers.

METHOD

This research was conducted for 60 days, starting from August 2022 through September 2022. The puerulus green lobster was kept in a plastic container which L x W x H (68 cm x 48 cm x 41cm =133.8 L) in Samudera Bahari Utama Cooperative, Girimukti Village, Pelabuhanratu, Sukabumi Regency.

Baby Lobsters were obtained from fishermen around the research location (Port Ratu Bay). Before getting the lobsters from fishermen, we prepare the media for raising the lobsters. In this research, we filled a container box with coral that we took from the coast and sterilized it with the aim of making the coral a natural lobster shelter. Once the media is ready to use, we buy baby lobster from fishermen according to needs and immediately start research (Figure 1).



Figure 1. Green Lobster Puerulus

The materials in this research were lobster seeds weighted on average 0.2 gram each with 5 different densities for treatments A (10/box or 75/m³), B (15/box or 112/m³), C (20/box or 150/m³), D (25/box or 188/m³) and E (30/box or 225/m³) with 3 repetitions.

The green lobster seeds to be tested were put into each cultivation medium in a container (box) equipped with an aquarium internal filter as a tool to maintain water quality. We used an electric filter and aerator. They were fed twice a day at 8 am and 17 pm.

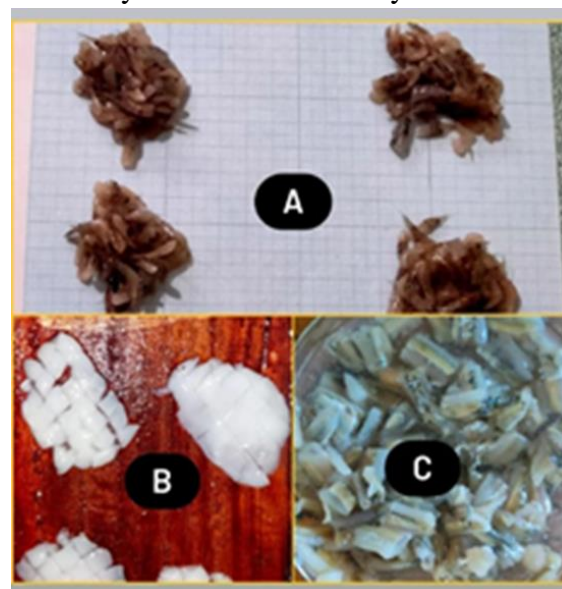


Figure 2. Natural Feed (A. Shrimp, B. Squid & C. Anchovy)

The feed (Figure 2) that will be given is previously cut into extra small pieces so the feed can be adjusted to fit the lobster's mouth. After 7 hours of feeding, the uneaten feed in the container box is cleaned using a siphon. The collected data was the test animal's response to treatments, including such parameters as: survival rate (SR), feeding efficiency (FE), growth rate (LP), Moulting Frequency (MF) and water quality. The weight was sampled once every 7 days randomly. The water quality parameters (temperature, total dissolve solid, potential hydrogen, dissolved oxygen, and salinity) were tested every morning.

Observational Parameter Formula

Lobster's Survival Rate (SR)

The survival rate was calculated using the following formula (Effendi, 2002):

$$SR = \frac{N_t}{N_0} \times 100\%$$

Where: SR = Survival rate (%)
N_t = Number of fish on day t (lobsters)
N₀ = Number of fish on day 0 (lobsters)

Feeding Efficiency (FE)

The feeding efficiency could be calculated using the following formula (Tacon, 1993 in Amalia, 2013):

$$FE = \frac{W_t - W_0}{F} \times 100\%$$

Where: FE = Feeding efficiency (%)
F = Amount of feeds given during research (g)
W_t = Average weight of seeds at the end of research (g)
W₀ = Average weight of seeds at the beginning of research (g)

Growth rate

The fish growth parameter was calculated using the absolute growth rate formula (Effendie, 1997):

$$W_m = W_t - W_0$$

Where: W_m = Absolute growth rate (g)
W_t = Average weight of seeds at the end of research (g)
W₀ = Average weight of seeds at the beginning of research (g)

Moulting Frequency

Moulting frequency was calculated using formula from Kibria (1993) :

$$FM (\%) = \frac{M}{N_x} \times 100\%$$

Where: FM = Moulting Frequency (%)

M = Sum of molting lobster
N = Sum of lobster each treatment

The obtained data was analyzed statistically by reviewing the observation with supporting data and relevant literature. Furthermore, a statistic analysis was carried out using completely randomized design (CRD). The obtained data was analyzed using the analysis of variance with F test to figure out the effect of each treatment and to see if any difference was found between treatments. When differences were found, the analysis was followed by Duncan's multiple range test at 95% confidence level (Gasperz, 1994).

RESULTS AND DISCUSSION

Survival Rate

Survival rate is a comparison between the number of organisms surviving by the end of research and the number of organisms at the beginning of research as expressed in percent. The greater the percentage is, the more organisms surviving during the research will be (Faizal et al., 2017). The survival rate of green lobster during the research ranged between 66% and 100% as shown in Figure 2.

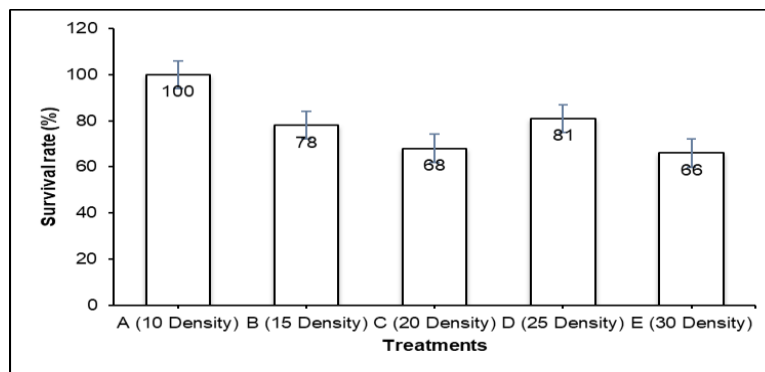


Figure 2. Survival Rate Of Puerulus Green Lobster In Every Stocking Density

Based on the measurement result, the highest survival rate was found in treatment A at 100%, followed by treatment D at 81%, treatment B at 78%, treatment C at 68% and treatment E at 66%.

Treatment A with its 10 lobsters/box was considered less efficient since its density was too low. This is supported by Prariska et al., 2020 who suggest that extremely low density will reduce the productivity since the profit earned fails to cover the total production costs spent, while extremely high density will be a limiting factor for lobsters as an aquatic animal living actively on the bottom of the water to move and compete to find foods. Stocking density is a factor that determines the success of a cultivation business. Lobsters with a low stocking density have a great opportunity to get a share of the food around them, besides that there are also fewer competitors around them. Based on research from Cokrowati (2012) show that the higher the stocking density, the lower the survival value. The difference in lobster survival rates in each treatment is due to the fact that the food consumed by lobsters at low density is quite effective and has a large opportunity to get oxygen and space to move.

Despite its higher density than treatments B (15 lobsters/box) and C (20 lobsters/box), treatment D (25 lobsters/box) had better survival rate. This was because of the high cannibalism

in treatments B and C. This is consistent with Lesmana and Mumpuni, 2021 who suggest that a low survival rate indicates higher cannibalism level.

Feeding efficiency

Feeding efficiency is a comparison between the value of weight gain and the total feeds used during the rearing period. The greater the value of feed efficiency is, the more processes of feed utilization by lobsters and the greater the weight gain will be (Iskandar & Elrifadah, 2015). The factors affecting this feeding efficiency, among other things, were the amount of feeding, the amount of feed consumption (feed energy content) and nutrition completeness in the feeds (Fitasari et al., 2016).

From Figure 3, it can be seen that the highest feeding efficiency was found in treatment A (10 lobsters/box) at 5.07% and followed by treatment D (25 lobsters/box) at 4.96%, treatment B (15 lobsters/box) at 4.9%, treatment E (30 lobsters/box) at 4,84 % and the treatment with the least value of feeding efficiency was treatment C (15 lobsters/box) at 4.82%. No significant differences were found in each treatment, since the lobsters were fed on a regular basis once every 2 days and at the same amount, i.e., 100% of body weight, and this led to the absence of competition for food among the lobster seeds. This is confirmed by Muqromah et al., 2016 who state that in a natural setting lobsters' growth is still less effective, at a 0.1 feed efficiency the value is still less than 40%.

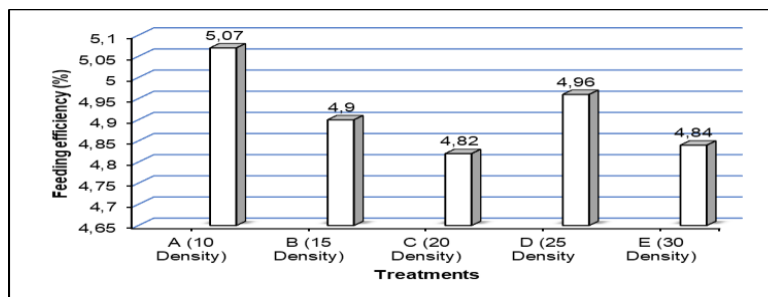


Figure 3. Feeding Efficiency In Puerulus Green Lobster In Every Stocking Density

Growth rate

Growth rate is the difference between the weight of an organism at the beginning of research and that at the end of research as expressed in a weight unit. The greater the result is, the faster the growth rate of that organism will be (Salamah & Zulpikar, 2020).

Based on Figure 4, it can be seen that the growth rate of green lobster seeds ranged between 2.28 and 2.4 grams. The highest growth rate was found in treatment A at 2.4 gram, and followed by treatment D at 2.35 gram, treatment B at 2.32 gram, and treatment E at 2.29 gram. The lowest growth rate was found in treatment C at 2.28 gram. Based on the observation, the growth rates were not significantly different between treatments. This was seen from the green lobster's average weight gain when it was sampled once every week. This is consistent with Pratiwi et al. (2016) who suggest that the green lobsters kept for 60 days using a compartment system show no significantly different growths in both their length and weight.

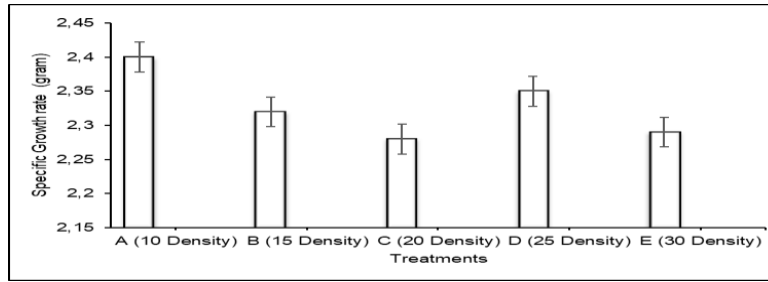


Figure 4. Growth rate in puerulus green lobster

Table 1. Weight Gain of Lobster

| Treatment | Wo (gram) | Wt (gram) | Average of Weight Gain of Lobster (gram) |
|-----------|-----------|-----------|--|
| A | 0,20 | 2, 64 | 2,44 |
| B | 0,20 | 2,48 | 2,28 |
| C | 0,20 | 2,49 | 2,29 |
| D | 0,20 | 2,56 | 2,36 |
| E | 0,20 | 2,49 | 2,29 |

Molting frequency

Molting is a process of removing the old cuticle and replacing it with a new cuticle (Lesmana & Mumpuni 2022). Moulting occurs at a certain time in crustaceans. When moulting occurs, crustaceans increase in length, width, and weight. Lobsters undergo skin changes throughout their lives which causes growth. The moulting process in lobsters is useful for accelerating growth. Moulting will also repair damaged lobster body parts such as broken legs and antennae and they can grow normally again

Based on observations, the frequency of molting of green lobster fry during the research (A = 75/m³), (B= 112/m³), (C = 150/m³), (D = 188/m³) and (E = 225/m³) ranged from 3.56 times/ to 4.4 times/56 days. The highest molting frequency value was in treatment A, 4.4 times, and the lowest molting frequency was in treatment E, 3.56 times/day.

The high molting frequency value, namely 4.4 times in treatment A with a density of 10 lobster/box, has a significant difference compared to the others, this is because treatment A has very high survival, which means it has a high molting frequency.

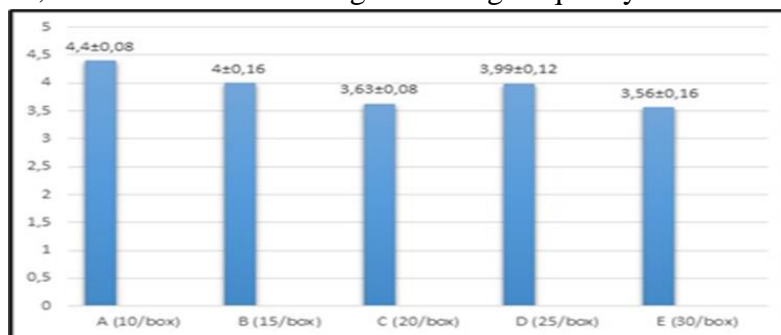


Figure 8. Molting Frequency in Different Density of Puerulus Green Lobster

Table 2. Duncan's Multiple Distance Test Moulting Frequency

| Treatments | Moulting Frequency |
|------------|--------------------|
| A | 4,4 ± 5,08 c |
| B | 4 ± 4,62 c |
| C | 3,63 ± 4,23 b |
| D | 3,99 ± 4,65 b |

| | |
|---|---------------|
| E | 3,56 ± 4,17 a |
|---|---------------|

Note: Values followed by the same letter are not significantly different according to Duncan's multiple range test at the 95% confidence level

Water quality parameters

Observing the water quality was used as a supporting parameter during this research. The water quality parameters measured included temperature, potential hydrogen (pH), dissolved oxygen (DO), total dissolved solid (TDS) and salinity. The measurement results showed that the water quality during the research was still eligible for rearing lobsters.

The results of observation on the water condition in the rearing media during the research with the five treatments showed that the fastest water media to get turbid was found in treatment E (30-lobster density) and followed by treatments D (25-lobster density), C (20-lobster density), B (15-lobster density) and A (10-lobster density). The water in the rearing media of treatments E and D began to be turbid on day 3 after the media preparation, and followed by treatment C on day 4 while treatments B and A got turbid on day 5.

Therefore, the water media shift pond was carried out 1 hour after feeding every day. However, the water was replaced only 3 cm at a maximum and the precipitating dirt was taken. This was because replacing the water too frequently at one time on regular basis would only make the lobster seeds stressed and they would eventually die. This is supported by Makasangkil et al. (2017) who suggest that replacing the water at high frequency can directly disrupt the lobsters in the rearing media, making the lobsters stressed. At the end of the day, it can negatively affect their health. The water quality measurements during the rearing period can be seen in the following table.

The average oxygen content in this research was 6.2 mg/L. This complied with the Indonesian National Standard (SNI) with DO for lobster rearing. In their research, Anggraeni et al., 2018 suggest that the water-dissolved oxygen for lobster rearing was 6-8 mg/l. Dissolved oxygen was the factor needed by lobsters to breath and the metabolism within the body that would produce activities, growth movement and reproduction.

Being too low or too high, potential hydrogen (pH) might disrupt the lobster's growth as a result of stress. According to the operating standard of lobster cultivation from the General Directorate for Cultivation Fisheries at the Ministry of Marine Affairs and Fisheries, the optimal pH for rearing green lobsters ranges between 7.8 and 8.5. In this research, it was 7.66, thus it could be said that it complied with the quality standard. Similarly, in their research, Anggraeni et.al. (2018) suggest that the water pH is 8.

In addition, temperature also serves as one factor that can affect lobsters' growth since it might affect their appetite and, thus, has some influence on their growth rate and feeding efficiency. During the rearing, the temperature ranged from 27 to 30°C. According to the Lobster Cultivation Operating Standard, the temperature should range between 29 and 31°C since it is the water quality value needed for lobster's growth and survival rates.

Salinity is the saltiness level or salt content dissolved in water (Patty, 2013). Salinity has a great effect on lobster's growth. When it is too high, the lobster's weight gain will be less optimal (Rahim et.al, 2015). The good salinity for lobster's growth ranges between 25 and 28 ppt (Makasangkil et.al 2017). During the lobster seed rearing, the salinity was found at 28 ppt, which perfectly supported the growth of lobster seeds.

Table 3. Water quality during research

| No | Parameters | Unit | Value in maintenance media |
|----|-----------------------------|------|----------------------------|
| 1 | Temperature | °C | 27 - 30 |
| 2 | potensial Hidrogen (pH) | - | 7,66 |
| 3 | Dissolved Oxygen (DO) | Mg/L | 6,2 mg/L |
| 4 | Total Dissolved Solid (TDS) | - | 115 |

CONCLUSION

The highest survival rate was found in treatment A (10 lobsters) at 100% survival rate and the highest feeding efficiency was also found in treatment A (10 lobsters) at 5.07%. As for the growth rate, the highest one was found in treatment A (10 lobsters) with 2.4-gram weight gain. While it had the highest results, treatment A was considered less efficient since it had an extremely low density.

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