The effect of thickness mangrove mud substrate media on growth and survival rate of sea worms (Nereis sp.)

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Abstract. Nereis sp. is a type of sediment-eating organism (deposit feeder) which harness organic materials provided by other organisms as food. Nereis sp. has slow growth, because thickness and the type of substrate in which it grows is less than optimal. The aim of this study is to examine the effect of mangrove mud substrate media thickness on the growth and survival rate of Nereis sp. Research animal in the form of Nereis sp. aged 2-3 months. Experimental media used in this study was mangrove mud substrate which has a high nutrient content with different thickness of substrate media. The experimental method used in this study was a completely randomized design (CRD) (4 treatments and 3 replications). Treatments A (thickness 3 cm), B (thickness 6 cm), C (thickness 9 cm) and D (thickness 12 cm). The results showed that treatment C has the highest absolute growth, SGR, FUE, FCR, PER and SR were 6.66 ± 1.18⁸, 0.43 ± 0.01⁸, 68.93 ± 12.67⁸, 1.35 ± 0.13³, 1.72 ± 0.34⁴, and 97.00 ± 3.61³. In conclusion the thickness of the mangrove mud substrate media significantly different (P<0.05) on Nereis sp.

1. Introduction

Sea Worm (Nereis sp.) is an invertebrate that belongs to the Annelida phylum, the body is segmented and a sediment-eating animal (deposit feeder) which harness organic materials provided by other organisms as food. Sea worm (Nereis sp.) plays an important role in the maturation of shrimp broodstock gonads and can be used as natural feed for shrimp broodstock. Sea worm has a high nutritional content. Basically, shrimp will grow faster if given high quality natural feed. According to [1] reported that the use of natural ingredients can reduce feed costs during production The most important factor on the growth and survival rate of sea worm (Nereis sp.) are the cultivation media and feed quality. Culture media with optimal thickness will stimulate the growth of sea worm (Nereis sp.) as well as feeding it with optimal nutritional content will spur the growth and survival rate of sea worm (Nereis sp.). According to [3] that the substrate media affects the survival of sea worms, this is because the substrate used has a high sand content therefore the worms need more energy to move.

The substrate used for sea worm cultivation are sand and muddy substrate. According to [3] reported that the natural habitat of sea worms are generally sandy and muddy, for example coastal areas adjacent to residential areas with high decomposite materials, estuary areas, and mangrove areas. The high catch of sea worms indicates that the composite material content in the mangrove area is higher than in the sand area. According to [4] reported that mangrove substrate has ecological functions in absorbing carbon, remediating pollutants, preventing abrasion, intrusion, and preventing. According to [5] reported that besides that, it also serves as habitat for the growth and development of aquatic fauna. According to [6] reported that mangrove mud in the Teluk Awur area, Jepara contains ammonia 0.09 mg/l and nitrite 0.2 mg/l which can be used as a place to find food (feeding ground) and...
breeding ground (spawning ground) for organisms in sea worm cultivation (Nereis sp.) substrate thickness is one of the key factors in increasing the growth of sea worms Nereis sp. Substrate thickness can be used to help the growth of biomass in sea worms Nereis sp. Energy depletion occurs in sea worms (Nereis sp.) when they swim and crawl which in turn will reduce its biomass, resulting in mortality of marine worms. For this reason, a substrate thickness test is needed to increase growth in sea worms (Nereis sp.). According to [7] that substrate depth for sea worm cultivation Nereis sp. ranged from 10-20 cm with a survival rate (SR) of 64-85%. Mangrove mud substrate can optimize survival rates and specific growth rates in sea worm cultivation.

According to [8] that previous research related to the effect of media thickness has been carried out on silk worms (Tubifex sp.) as the cultivant and the media used are different. The thickness of the substrate can be used to assist biomass growth in sea worms Nereis sp. The purpose of this study is to examine the effect of the best media thickness of the mangrove mud substrate for sea worms (Nereis sp.) to absolute growth, the specific growth rate / Specific Growth Rate (SGR), feed utilization efficiency (FUE), feed conversion ratio (FCR), protein efficiency ratio (PER) and survival rate (SR).

2. **Material and methods**

The research animals used in this study were sea worms (Nereis sp.) in the enlargement phase with age range of 2 - 3 months and initial weight of ± 0.15 - 0.5 gr. Sea worms (Nereis sp.) came from PT. Matahari Cipta Sentosa, Situbondo, East Java. There were 45 sea worms per container. The containers used in the study were 12 plastic containers with a volume of 30 liters. Before use, the container is cleaned with soap and water and then dried to prevent dirt from sticking. The seawater used comes from a reservoir that has gone through the sterilization stage using chlorine 10 ppm and neutralized with sodium thiosulfate 5 ppm. Feeding is carried out in the morning and at night at 07.00 WIB and 19.00 WIB with regular feeding fix feeding rate 5% of the weight of the biomass. Feeding is done by shrinking the water about 1 cm from the surface of the substrate.

This study was conducted by using experimental methods to test the thickness of the media used as a cultivation media to produce the best results. The experimental design used in this study was a completely randomized design (CRD). RAL is used in research that is homogeneous (single treatment) and the treatment is completely randomized to experimental units. This study used 4 treatments and each treatment was repeated 3 times, the arrangement of the treatments was as follows: treatment A: using mangrove mud media with a thickness of 3 cm; treatment B: using mangrove mud media with a thickness of 6 cm; treatment C: using mangrove mud media with a thickness of 9 cm; treatment D: using mangrove mud media with a thickness of 12 cm.

The results obtained according to [7] the mangrove mud substrate can optimize survival rate and specific growth rate in sea worm cultivation. The variables studied are absolute growth, specific growth rates / specific growth rate (SGR), feed utilization efficiency (FUE), feed conversion ratio (FCR), protein efficiency ratio (PER), survival rate (SR) and water quality.

2.1. **Observation variables**

2.1.1. **Absolute growth (Wm)**

Absolute growth (Wm) is calculated by the formula, according to [9]:

\[
Wm = Wt - W0
\]

Where Wm is the average absolute growth of research animals (g), Wt is the average weight of research animals at the end of the study (g), W0 is the average weight of research animals at the beginning of the study (g)

2.1.2. **Specific growth rate**

The specific growth rate is calculated by the formula according to [10] as follows:

\[
SGR = \frac{\ln Wt - \ln W0 \times 100}{t}
\]
Where SGR is the specific growth rate (%), Wt is the mean weight of worms at the end of the study (g), Wo is the mean weight of worms at the beginning of the study (g)

2.1.3. Feed utilization efficiency (FUE)
Feed utilization efficiency (FUE) was calculated using the according to [11] as follows:

\[ FUE = \frac{W_t - W_0 \times 100\%}{F} \]

Where FUE is the Efficiency of Feed Utilization (%), Wt is the final biomass at the end of the study (g), Wo is the initial biomass at the beginning of the study (g) and F is the amount of feed consumed by the worms during the study

2.1.4. Feed conversion ratio (FCR)
The calculation of the feed conversion ratio is based on the according to [11] as follows:

\[ FCR = \frac{F}{(W_t + D) - W_0} \]

Where FCR is the feed conversion ratio, F is the amount of feed given (g), Wt is the weight of fish biomass at time t (g), Wo is the fish biomass weight at the beginning of cultivation (g), D is the fish biomass weight that died during cultivation (g)

2.1.5. Protein efficiency ratio (PER)
The protein efficiency ratio can be calculated using the according to [9] formula:

\[ PER = \frac{W_t - W_0 \times 100\%}{P_i} \]

PER is protein efficiency ratio, Wt is the biomass weight of research animals at the end of cultivation (g), Wo is the biomass weight of research animals at the beginning of cultivation (g) and Pi is the protein content x amount of feed consumed

2.1.6. Survival rate (SR)
The survival rate formula according to [9] is:

\[ SR = \frac{N_0 - N_t \times 100\%}{N_0} \]

Where SR is survival rate, Nt is the number of individuals at the end of the study t, No is the number of individuals at the beginning of the study t = 0

2.1.7. Water quality
Measurement of water quality includes temperature, salinity, DO (dissolve oxygen) and pH taken in the morning and evening. DO measurement was carried by using DO meter, temperature measurement was carried by using thermometer, salinity measurement was carried by using refractometer, and pH measurement was carried by using pH meter.

2.2. Data analysis
The data obtained were analyzed using Analysis of Variance (ANOVA). Normality test, homogeneity test and additivity test was first carried out to determine that the data was normal, homogeneous and additive. If it is known that there is a real effect (P<0.05) or very real (P<0.01), then proceed with the
Duncan Multiple Area Test to determine the difference in the mean between treatments and also to determine the best treatment. Water quality data were analyzed descriptively.

3. Result and discussions
3.1. Result

Absolute growth and specific growth rate

Based on the study, histograms were obtained as the results of absolute growth values and specific growth rates in sea worms (*Nereis* sp.), as shown in Figure 1.

![Figure 1. Histogram of the results of absolute growth values and specific growth rates in sea worms (*Nereis* sp.) for 30 days cultivation](image)

The highest absolute weight value occurred in treatment C with media thickness of 9 cm, namely 6.66 gr, while the lowest absolute weight value was in treatment A with media thickness of 3 cm, namely 4 gr. The highest specific growth rate value occurred in treatment C with media thickness of 9 cm, namely 0.43%, while the lowest specific growth rate value was in treatment A with media thickness of 3 cm, namely 0.31%. The results of analysis of variance (ANOVA) showed a significant effect (P <0.05).

Feed utilization efficiency, feed conversion ratio and protein efficiency ratio

Based on the study, histograms were obtained as the value of the efficiency of feed utilization, feed conversion ratio and protein efficiency ratio in sea worms (*Nereis* sp.), as presented in Figure 2.
The highest value of feed utilization efficiency occurred in treatment C with media thickness of 9 cm, namely 68.93% while the lowest feed utilization efficiency value was in treatment A with media thickness of 3 cm, namely 40.88%. Score feed conversion ratio The highest occurred in treatment C with media thickness of 9 cm, namely 1.35% while the value feed conversion ratio The lowest was treatment A with media thickness of 3 cm, namely 2.26%. The highest protein efficiency ratio value occurred in treatment C with media thickness of 9 cm, namely 1.72%, while the lowest protein efficiency ratio value was in treatment A with media thickness of 3 cm, namely 1.02%. The results of analysis of variance (ANOVA) showed a significant effect (P <0.05).

Survival rate
Based on the study, a histogram of survival results on sea worms (Nereis sp.) was obtained, as shown in Figure 3.
Figure 3. Histogram of survival values for sea worms (Nereis sp.) during 30 days cultivation

The highest survival rate occurred in treatment C with media thickness of 9 cm, namely 97%, while the lowest survival value was in treatment A with media thickness of 3 cm, namely 83.67%. The results of analysis of variance (ANOVA) showed a significant effect (P <0.05).

Water quality
Based on the study the value of water quality was obtained as supporting data including dissolved oxygen or dissolved oxygen (DO), salinity, degree of acidity or power of hydrogen (pH) and temperature, the results are presented in Table 1.

| Variable          | Range     | Feasibility According to Literature |
|-------------------|-----------|-------------------------------------|
| DO (mg/l)         | 5-6.5     | 0.8-9.3 **                          |
| pH                | 7-8.4     | 7-8.5 **                            |
| Temperature (°C)  | 28-31     | 25-31 *                             |
| Salinity          | 29-31     | 25-40 **                            |

Information :
[12] *
[13] **

Water quality parameters that were measured in sea worm cultivation (Nereis sp.) for 30 days showed that the values of the variables DO, salinity, pH, temperature are still in the appropriate range to be used as media for cultivation to support sea worms (Nereis sp.). This is supported from the literature on optimum water quality conditions for sea worm cultivation (Nereis sp.).

3.2. Discussion

Growth
Based on the study, it can be observed that the growth of sea worms (Nereis sp.) can be affected by the cultivation media and feed quality. The thickness of the mangrove mud substrate media was proven to have a significant effect (P <0.05) on absolute growth, specific growth rates, feed utilization efficiency, feed conversion ratio, protein efficiency ratio, and the survival rate of sea worms. The cultivation media used as an alternative to cultivate sea worm is substrate of mangrove mud. Mangrove mud contains soft clay substrate, where sea worms can adapt to this texture. According to [6] that mangrove mud in the TelukAwur area, Jepara contains ammonia 0.09 mg/l and nitrite 0.2 mg/l which is a suitable place to find food and a breeding ground for organisms. Substrate that contains more sand and watery such as mud will affect sea worms activities. Sea worms will require more energy to carry out activities, therefore it can accelerate growth. Sea worms (Nereis sp.) can also
forage for food in the substrate. According to [14] that study, ecologically, the substrate in the mangrove ecosystem acts as a life support system for various aquatic organisms and terrestrial organisms both as a place to find food (feeding ground), place of care (nursery ground) and breeding grounds (spawning ground). The thickness of the substrate used in the study were different, including 3cm thickness, 6 cm, 9 cm, and 12 cm. The thickness of the media also affects the cultivation of sea worms for 30 days. The thicker the media used, the greater the energy needed for the sea worms to carry out activities. It can be concluded that with substrate thickness of 9 cm, sea worms (Nereis sp.) grow and develop well. This is because sea worms (Nereis sp.) can carry out their activities easily and do not require much energy when foraging in the substrate with thickness of 9 cm. The substrate also contains organic material which is good as a feed balance. In contrast with media thickness of 3 cm and 6 cm in treatment A and B, it is presumed that the less substrate used for cultivation media, the less growth the sea worms will have, due to the competition between sea worms (Nereis sp.). This is due to the difficulty the research animals have in obtaining large space and oxygen. Substrate thickness of 12 cm was the highest media thickness used in the study. At this thickness it can be observed that sea worms (Nereis sp.) have poor growth compared to media thickness of 9 cm. This is presumed to be caused by a large energy drain experienced by the sea worms when finding food and obtaining oxygen become increasingly difficult. According to [7] study, energy of sea worms. This is also supported by [15] that study, sea worms that live in holes tends to save energy in their body, therefore will increase their biomass. It can be observed that oxygen plays an important role in stimulating the growth of organisms. This is also confirmed by the study of [7] that the texture of the sand plays a role in oxygen exchange process as well as the entry of nutrient particles (organic matter) in the substrate. While clay texture acts as a storage for organic matter particles in the substrate.

The value of the specific growth rate observed in this study showed that treatment C with media thickness of 9 cm was greater than treatment A with media thickness of 3 cm, B with media thickness of 6 cm and D with media thickness of 12 cm. The result of the specific growth rate in treatment C was 6.29% with substrate thickness of 9 cm. The lowest specific growth rate occurred in treatment A of 4.60%. The low specific growth rate is presumed to be caused by the low consumption of feed in treatment A (substrate thickness of 3 cm). The value of the specific growth rate indicates growth support and is related to the absolute growth of sea worms (Nereis sp.). Growth speed can be used to determine the quality of the feed given. According to [3] seen from the value of the specific growth rate, showed that the feed given has good quality. This is because the type of feed used in the study uses animal ingredients which are easier for the worms to digest. Feeding is carried out in the morning at 07.00 WIB and at night at 19.00 WIB with regular feeding fix feeding rate 5% of the biomass weight. On treatment A, B, C and D with media thickness of 3 cm, 6 cm, 9 cm and 12 cm biomass weights ranged from 4 to 6.6 gr and obtained the best results in treatment C, namely 6.6 gr because the greater the weight of the biomass produced, the higher the percentage of feed given will be. The specific growth rate which tends to be higher provides a considerable opportunity for the ability of worms to carry out tube formation activities, decomposition of organic matter and exchange processes for relatively perfect oxygen supply.

Based the results of the study, the feed given was in the form of Fengli-0 powder feed with protein content of 40% which resulted in the highest feed utilization efficiency and protein efficiency ratio in treatment C with a medium thickness of 9 cm, respectively 68.93% and 1.72%. These results indicate that the feed is digested properly by sea worms so that the feed is absorbed by the sea worms body effectively and efficiently. The high and low efficiency of feed utilization is influenced by the source of nutrition and the amount of each component of feed nutrition, while the feed conversion ratio value or the best feed conversion in treatment C with a medium thickness of 9 cm at 1.35%. Feed conversion ratio value obtained from the comparison between the amount of feed given and the amount of weight produced. The high feed conversion value is presumed due to the feed given is not fully utilized by the sea worms. The low feed conversion value indicates that the feed is used efficiently. Feed conversion is the ratio between the amount of food given and the weight gained, the lower the FCR value, the more efficient the animal converts its food into energy source. According to
that the high and low efficiency of using feed protein depends on several factors, including protein quality, protein content in feed such as fat and carbohydrates and the frequency of feeding.

Survival rate of sea worm (Nereis sp.) for 30 days of cultivation has a significant effect when they were given powder feed from vanname shrimp larvae, namely Fengli-0, therefore can be used as an alternative feed to meet the survival value or good survival. The high survival rate indicates that the quality and quantity of feed given are sufficient to meet basic needs and even increase growth. Sea worms (Nereis sp.) in the treatment using mangrove mud substrate in a condition that is not stressful, so that the sea worms can consume the feed optimally which is used for growth. According to [14] the role of the substrate type of sea worm life (Nereis sp.) is closely related to the function and nature of each texture, as well as the habit patterns of sea worms on their movement ability and distinctive characteristics, so that they can support the life of sea worms Nereis sp and can trigger the growth of sea worms Nereis sp. The high survival rate is also influenced by the cultivation media used. Generally, sea worms (Nereis sp.) can live in estuarine areas with sandy mud substrate conditions. This study, using a medium in the form of mangrove mud for sea worms (Nereis sp.) cultivation. According to [7] that sea worms are detritus (eat the remains of organic material or deposit feeder (sediment eater). Based on this, sea worms can take advantage of the organic material contained in the substrate as natural food, which resulted in a greater growth rate.

Water quality

Water quality is an environmental factor that plays an important role in the success of aquaculture business, so water quality must be managed in accordance to optimal standards in order to support the growth and survival of research organisms. From the research results, did not show any fluctuations in the measured parameters, where each parameter indicates that the water quality obtained is good enough for growth. One of the most important factors in cultivation activities is the availability of good water. Water can be one of the determinants of the growth rate and health of the living things that live in it. The range of water quality during cultivation resulted in DO values ranging from 5-6.5 mg/l, pH ranging from 7-8.4, temperatures ranging from 28-31°C and salinity ranging from 29-31 ppt. According to [17] the water quality suitable for sea worms at temperatures ranging from 23-32°C and salinity ranging from 14-31ppt.

Water quality during sea worm cultivation (Nereis sp.) can considered suitable due to the good results of its growth and survival rate. Optimal water quality standards are also considered to support the growth and survival of organisms. The survival rate of organisms is influenced by good cultivation management including stocking density, feed quality, water quality, parasites or disease. In the study of [2] that abundance of Nereis sp. is greatly influenced by environmental conditions both the substrate and water.

4. Conclusion

The conclusions that can be obtained from this study are as follows:

1. The thickness of the mangrove mud substrate had a significant effect (P <0.05) on absolute growth, specific growth rate (SGR), feed utilization efficiency (EPP), feed conversion ratio (FCR), protein efficiency ratio (PER) and survival rate (SR) in sea worms (Nereis sp.).
2. The best results were in treatment C with medium thickness of 9 cm which resulted in absolute growth values, SGR, EPP, FCR, PER, and SR of 6.66±1.18gr, 0.43±0.01b%, 68.93±12.67%, 1.35 ± 0.13%, 1.72±0.34% and 97.00±3.61b%. Where as in treatment A with medium thickness of 3 cm had the lowest yield with absolute growth, SGR, EPP, FCR, PER and SR namely 4.00±0.55gr, 0.31±0.03%, 40.88±5.67%, 2.26±0.26%, 1.02±0.14% and 83.67±5.51%.

5. References

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