

Effect of Fish Meal Substitution with Sea Worm Flour (*Nereis* sp.) in Diet on Growth and Survival Rate of Pacific White Shrimp (*Litopenaeus vannamei*) Post Larvae

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Abstrak

Pacific white shrimp (*Litopenaeus vannamei*) is one of high economic value fishery commodity in Indonesia. One of the obstacles faced by cultivators is the high feed price reaching half of the total production cost. Due to the high cost of fish meal the main raw of feed material, fish meal was substituted with sea worm (*Nereis* sp.) flour having similar or higher nutritional content with more affordable prices and available abundantly. The purpose of this study then was to examine the effect of substitution of fish meal with marine worm (*Nereis* sp.) meal in diet on the growth and survival rate of pacific white shrimp (*L. vannamei*) and to examine its best dose. This study used an experimental method with a completely randomized design (CRD) of four treatments and triplicates. The doses were A: 0%, B: 25%, C: 30% and D: 35% flour *Nereis* sp., respectively. The test animals used were pacific white shrimp (*L. vannamei*) post larvae (PL) 15. Shrimp were reared in a container of 43x30x25 cm³ filled with six liters seawater. Shrimps were reared for 42 days with a stocking density of 30 pcs/container. The results showed that the substitution of fish meal with sea worm meal (*Nereis* sp.) in the diet had a significant effect ($P<0.05$) on the growth and survival rate of PL15 pacific white shrimp (*L. vannamei*). The highest value for total feed consumption, relative growth rate, feed utilization efficiency, food conversion ratio, protein efficiency ratio and survival rate were found in treatment C (30% *Nereis* sp. flour) with successive values of 80,61 g, 3,84 %/day, 72,01%, 1,39%, 1,67% and 100,00%, respectively.

Key words: *L. vannamei*, *Nereis* sp., Growth, Survival Rate

Introduction

Pacific white shrimp (*Litopenaeus vannamei*) is one of high economic value fishery commodities. Started to be cultivated in Indonesia in 2001. Some of the advantages of this shrimp species include being responsive to feed, resistant to disease, fast growth, able to live at high stocking densities, relatively short maintenance period of about 90-100 days per cycle and have a high survival rate. Purnamasari *et al.*, 2017). The success of an aquaculture business is influenced by several important factors, one of them is feed. Shrimp farming spends about 50% of the total production cost for feed (Zuliyani *et al.*, 2017). The needs of fish meal can be met because most of it is obtained from import and therefore, the price is expensive and becomes one obstacles in shrimp farming. Alternatives for feed raw materials are required with high protein, affordable and able to replace fish meal either partially or completely (Pinandoyo *et al.*, 2021). According to Hadiyanto (2013), which states that marine

worms have the potential as natural food for shrimp.

The sea worm (*Nereis* sp.) has high economic value and has the potential to be developed. Sea worms live in tidal areas on both sandy, muddy and sandy loam substrates (Asnawi *et al.*, 2018). Utilization of sea worms as natural and artificial feed for shrimp because of the high nutritional content. Potential of *Nereis* sp. as shrimp feed is due to high levels of both amino acids and unsaturated fatty acids. A high protein content and has essential fatty acids, especially arachidonic acid (ARA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which plays a role in stimulating gonadal maturation broodstock (Subaidah *et al.*, 2017). Sea worms contains protein ranging from 42.06 to 51.68% and fat ranging from 12.93 to 22% to meet the nutritional needs of shrimp (Wibowo *et al.*, 2020).

Protein requirements to support the growth and survival rate of Pacific white shrimp post larvae range from 30 – 50% (Yustianti *et al.*,

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2013). Pacific white shrimp with stadia Z1 – PL 10 can be given artificial feed in the form of flour, pasta or flake (SNI, 2009). According to Arsad *et al.*, (2017), that the intensity of feeding Pacific white shrimp in the form of fish meal and pellets started at PL 1-15 2 times, PL 16-70 4 times and PL 71-120 5 times per day. Based on research by Yuwono (2005), there was an increase in the growth of shrimp fry fed with feed containing 30% worm flour and post larvae of tiger prawns, the survival rate reached 95.67% after being fed with shredded lurworms. Based on this research, the authors are interested in conducting further research related to the effect of using sea worm flour as a substitute for fish meal in artificial feeds on the growth and survival of PL 15 vannamei shrimp (*L. vannamei*).

The purpose of this study was to examine the effect of substitution of fish meal with marine worm meal (*Nereis* sp.) in diet on the growth and survival rate of pacific white shrimp (*L. vannamei*) and to examine the best dose on the growth and survival rate of white shrimp (*L. vannamei*).

Material and Methods

The test animals used in this study were vaname shrimp (*L. vannamei*) post larval stage from Marine Science Techno Park (MSTP) UNIP in Jepara, Central Java. The shrimp used were 12 days old on the first day of collection, for further adaptation of the feed for 3 days. By the time it reaches PL 15 the shrimp are ready to be used for research.

The maintenance container used in this study was a container with a size of 43 x 30 x 25 cm³ filled with six liters seawater. The containers used were 12 equipped with aeration and warings used as container covers to prevent shrimp from jumping out. Containers were sterilized before use.

The maintenance medium used was sea water with a salinity of 29-30 ppt. The source of the water comes from sea water which has previously been accommodated,

filtered and then sterilized using chlorine at a dose of 10 g/ton, then neutralized using thiosulfate.

This study used an experimental method with a completely randomized design (CRD) of 4 treatments and 3 replications. According to Setyanto (2013), the experimental research method is used to see the effect of the causal relationship between the dependent variable and the independent variable and compare it with the control variable. This study used 4 treatments and each treatment was repeated 3 times, the arrangement of the treatments was as follows:
Treatment A : 0% sea worm flour (*Nereis* sp.)
Treatment B : 25% sea worm flour (*Nereis* sp.)
Treatment C : 30% sea worm flour (*Nereis* sp.)
Treatment D : 35% sea worm flour (*Nereis* sp.)

The process of making test feed begins with making sea worm flour. The process begins with washing the sea worms using running water until clean, then dried using an oven at 50°C for approximately 6 hours until dry and then mashed using a blender and filtered to get fine flour particles. The test feed raw materials used were sea worm flour, fish meal, shrimp head flour, soybean meal, bran flour, fish oil, corn oil, Vit-Min mix and CMC.

The following are the nutritional content of feed raw materials and test feed formulations presented in Tables 1 and 2.

Based on the statement of Haryono *et al.*, (2015), that the process of making feed begins by mixing all the raw materials from the smallest to the largest in number. The mixed material is added with warm water (50-60°C) slowly, then the feed is printed with a coconut filter. Bake in the oven at a temperature of approximately 30°C until dry.

The maintenance of the test animals was carried out for 42 days. Feeding management uses the at satiation method with the frequency of feeding 3 times/day at 8 am, 2 pm and 8 pm. Feeding was done by weighing the feed for a day and after feeding at night, weighing the remaining feed from the total feed that was weighed at the beginning before being given. Water quality management is carried out by siphoning twice a day at 6 am and 4 pm to

Table 1. Proximate Analysis Results of Feed Raw

Materials	Component (%)						Total (%)
	Water	Protein	BETN	Crude Lipid	Crude Fiber	Ash	
Fish meal ¹	8,65	45,70	12,27	6,18	3,26	23,94	100
Sea worm flour ²	15,92	61,11	3,87	9,64	0,82	8,64	100
Prawn head meal ³	11,98	30,45	4,69	2,87	5,26	44,75	100
Soybean meal ⁴	9,32	50,37	28,58	1,33	2,29	8,11	100
Bran meal ¹	11,48	6,36	30,13	1,59	34,77	15,67	100

Source: ¹Hernowo *et al.*, (2020); ²The results of the proximate analysis of the Laboratory of Nutrition and Feed Sciences, Faculty of Animal Husbandry and Agriculture, Diponegoro University (2021); ³Sudrajat and Effendi (2002); ⁴Wibowo *et al.*, (2020).

maintain water quality by replacing dirty water with new water as much as the volume of wasted water (Widyantoko *et al.*, 2015). Leftover feed and feces were siphoned by suction using small hose to remove them.

Table 2. Formulation of Test Feed

Ingredients	Feed Composition (%/100 g Feed)			
	A (control)	B	C	D
Fish meal	35,00	30,00	25,00	0,00
Sea worm flour	0,00	25,00	30,00	35,00
Prawn head meal	14,08	15,08	12,90	18,64
Soybean meal	27,27	7,27	6,28	18,12
Bran meal	4,55	13,55	16,82	18,94
Fish oil	2,00	2,00	2,00	2,00
Corn oil	2,00	2,00	2,00	2,00
Vit-Min mix	3,00	3,00	3,00	3,00
CMC	2,00	2,00	2,00	2,00
Total (%)	100	100	100	100
Protein (%)	43,47	43,46	43,47	43,48
BETN (%)	18,78	12,92	13,13	14,86
Fat (%)	7,46	9,74	9,95	9,23
En. (kkal/g)	390,49	387,90	390,76	391,17
E/P Ratio	8,98	8,93	8,99	9,00

The data displayed includes data on total feed consumption, relative growth rate, feed utilization efficiency, food conversion ratio, protein efficiency ratio, survival rate and water quality.

Total Feed Consumption

Total feed consumption can be calculated using the formula according to Weatherly (1972), as follows:

$$F = C - S$$

Information :

F : Total feed consumed (g)

C : Feed given (g)

S : Leftover feed (g)

Relative Growth Rate

The relative growth rate (RGR) can be calculated by the formula of De Silva and Anderson (1995) as follows:

$$RGR = \frac{W_t - W_0}{W_0 \times t} \times 100\%$$

Information:

RGR : Relative growth rate (%/day)

Wt : Weight of test animals at the end of the study (g)

W0 : Weight of test animals at the beginning of the study (g)

t : Maintenance time (days)

Feed Utilization Efficiency

Feed utilization efficiency can be calculated using the formula according to Zonneveld *et al.*, (1991), as follows:

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

Information :

EPP : Feed utilization efficiency (%)

Wt : Final weight of fish (g)

W0 : Initial weight of fish (g)

F : Amount of feed consumed (g)

Food Conversion Ratio

The feed conversion ratio can be calculated using the formula according to Halver and Hardy (2002), as follows:

$$FCR = \frac{P}{(B_t + B_d) - B_o}$$

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Information :

P : Total feed consumption (g)

Bt : Final fish biomass (g)

Bd : Dead fish biomass (g)

Bo : Initial fish biomass (g)

Protein Efficiency Ratio

Protein Efficiency Ratio (PER) can be calculated using the formula according to Tacon (1993), as follows:

$$PER = \frac{Wt - Wo}{Pi} \times 100\%$$

Information :

Wt : Final weight of fish (g)

Wo : Initial weight of fish (g)

Pi : Amount of protein consumed (g)

Survival Rate

The survival rate formula based on Effendie (1997) is:

$$SR = \frac{Nt}{No} \times 100\%$$

Information :

SR : Survival rate (%)

Nt : Number of individuals at the end of the study (tails)

No : Number of individuals at the beginning of the study (tails)

Water Quality

Water quality measurements include: temperature, pH, salinity, dissolved oxygen (DO) which are measured using the Water Quality Checker (WQC) at 8 am and 4 pm and ammonia measurements were carried out at the beginning and end of maintenance by taking water samples at random from all treatments and replications.

Data Analysis

The data obtained were analyzed statistically by performing normality test, homogeneity test and additivity test. The results obtained were then analyzed for variance (ANOVA). The analysis of variance of the F test was used to determine the difference between the 95% ($P < 0.05$) and 99% ($P < 0.01$) confidence levels. These steps are requirements for conducting a Completely Randomized Design (Hidayat *et al.*, 2014). According to Srigandono (1981), who stated that if the results of analysis of variance (ANOVA) had a significant ($P < 0.05$) or very significant ($P < 0.01$) effect, the Duncan Multiple Region test was conducted to determine

the difference in the mean value between treatments. Analysis of water quality data was carried out descriptively for further comparison with the feasibility value in the existing reference. Water quality data were analyzed descriptively.

Result

Total Feed Consumption (TKP)

Based on research, the results obtained from total feed consumption of post larvae Pacific white shrimp (*L. vannamei*) are presented in Figure 1.

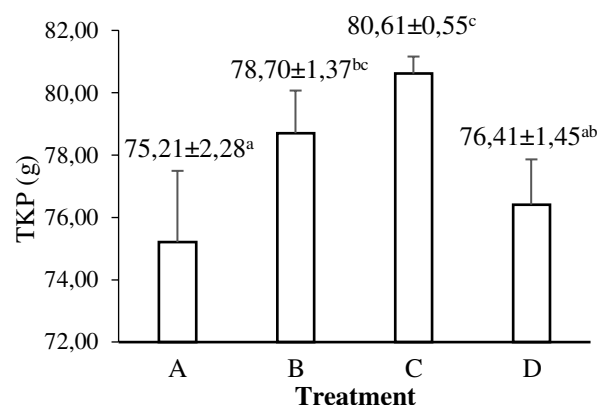


Fig 1. Total feed consumption of post larvae Pacific white shrimp (*L. vannamei*)

Based on these measurements, it can be seen that the highest total post larval feed intake of Pacific white shrimp (*L. vannamei*) was treated with a dose of sea worm flour (*Nereis* sp.) as much as 30% (C), which is 80.61 grams, and the lowest total value of feed consumption with a value of 75.21 grams in the treatment with a dose of sea worm flour (*Nereis* sp.) 0% (A). The results of the analysis of variance (ANOVA) showed a significant effect ($P < 0.05$).

Relative Growth Rate (RGR)

Based on research, the results obtained from the relative growth rate of post larvae Pacific white shrimp (*L. vannamei*) are presented in Figure 2.

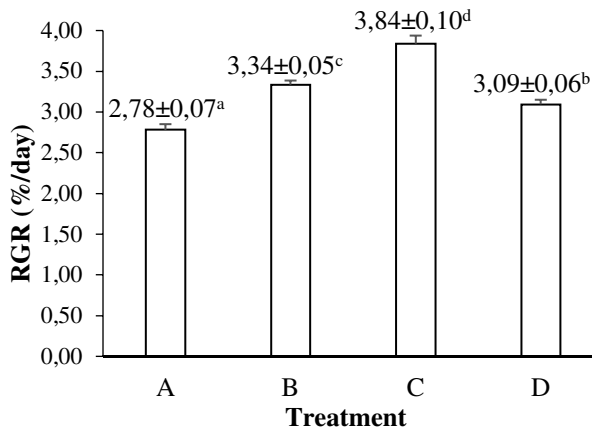


Fig 2. Relative growth rate of post larvae Pacific white shrimp (*L. vannamei*)

Based on these measurements, it can be seen that the relative growth rate of post larvae of Pacific white shrimp (*L. vannamei*) was highest in the treatment with a dose of sea worm flour (*Nereis* sp.) as much as 30% (C), which is 3.84%/day, and the lowest value was in the treatment with sea worm flour (*Nereis* sp.) 0% (A) which is 2.78%/day. The results of the analysis of variance (ANOVA) showed a significant effect ($P < 0.05$).

Feed Utilization Efficiency (EPP)

Based on research, the results obtained from feed utilization efficiency of post larvae Pacific white shrimp (*L. vannamei*) are presented in Figure 3.

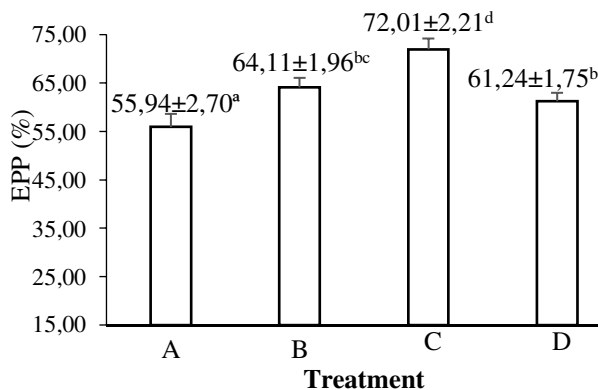


Fig 3. Feed utilization efficiency of post larvae Pacific white shrimp (*L. vannamei*)

Based on these measurements, it can be seen that the feed utilization efficiency of post larvae of Pacific white shrimp (*L. vannamei*) was

highest in the treatment with a dose of sea worm flour (*Nereis* sp.) as much as 30% (C), which is 72.01%, and the lowest value was in the treatment with sea worm flour (*Nereis* sp.) 0% (A) with a value of 55.94%. The results of the analysis of variance (ANOVA) showed a significant effect ($P < 0.05$).

Food Conversion Ratio (FCR)

Based on research, the results obtained from the food conversion ratio of post larvae Pacific white shrimp (*L. vannamei*) are presented in Figure 4.

Based on these measurements, it can be seen that the food conversion ratio of post larvae of Pacific white shrimp (*L. vannamei*) was highest in the treatment with a dose of sea worm flour (*Nereis* sp.) as much as 0% (A), which is 1.89% and the lowest value was in the treatment with sea worm flour (*Nereis* sp.) flour 30% (C) which is 1.39%. The results of the analysis of variance (ANOVA) showed a significant effect ($P < 0.05$).

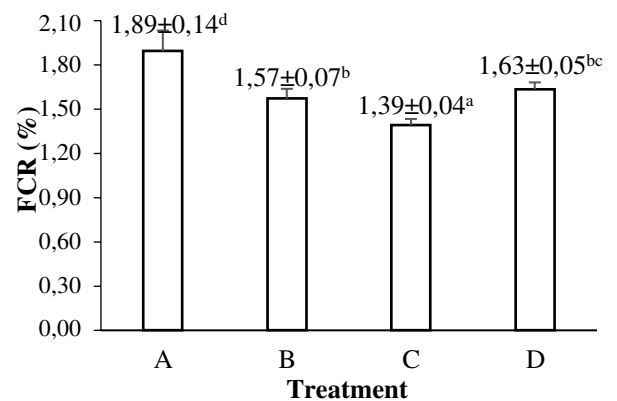


Fig 4. Food conversion ratio of post larvae Pacific white shrimp (*L. vannamei*)

Protein Efficiency Ratio

Based on research, the results obtained from the protein efficiency ratio of post larvae Pacific white shrimp (*L. vannamei*) are presented in Figure 5.

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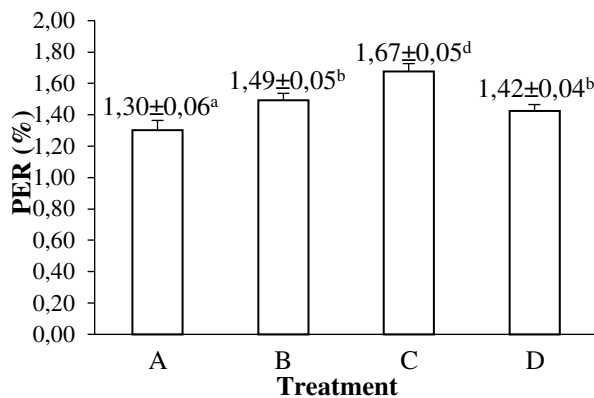


Fig 5. Protein efficiency ratio of post larvae Pacific white shrimp (*L. vannamei*)

Based on these results, it can be seen that the highest protein efficiency ratio (PER) value of post larval Pacific white shrimp (*L. vannamei*) feed was found in the treatment with a dose of sea worm flour (*Nereis* sp.) 30% (C), which is 1.67%, and the lowest value in the treatment with a dose of sea worm flour (*Nereis* sp.) 0% (A), which is 1.39%. The results of the analysis of variance (ANOVA) showed a significant effect ($P < 0.05$).

Survival Rate (SR)

Based on research, the results obtained from the survival rate of post larvae Pacific white shrimp (*L. vannamei*) are presented in Figure 6.

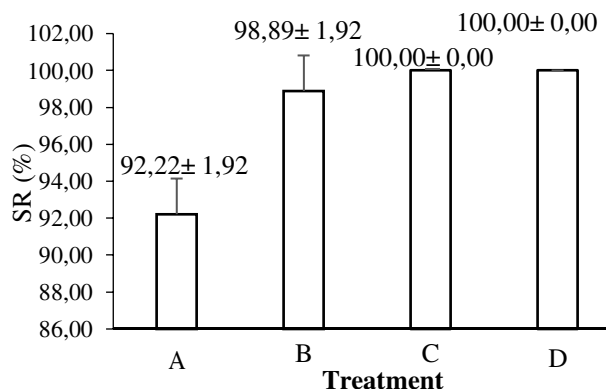


Fig 6. Survival rate of post larvae Pacific white shrimp (*L. vannamei*)

Based on these results, it can be seen that the highest value of survival rate (SR) for post larvae of Pacific white shrimp (*L. vannamei*) is in the treatment with a dose of sea worm flour (*Nereis* sp.) of 30% (C) and the treatment with a dose of sea worm flour (*Nereis* sp.) of 35% (D), which is equal to 100.00%. Treatment with a dose of sea worm flour (*Nereis* sp.) 0% (A) has the lowest survival rate, which is 92.22%.

Water Quality

Based on the research that has been done, the value of water quality was obtained for rearing post larvae of Pacific white shrimp (*L. vannamei*) during the study. The water quality parameters measured included dissolved oxygen (DO), pH, temperature, salinity, and ammonia. The results of water quality measurements are presented in Table 3.

Table 3. The results of the measurement of water quality parameters post larvae of Pacific white shrimp (*L. vannamei*) during rearing

No	Parameters	Measurement	Feasibility
		Results	
1.	Temperature (°C)	28,2-32,4	28-32 ^a _b
2.	pH	7,41-8,3	7-8,5
3.	DO (mg/l)	3,89-5,67	>3 ^b
4.	Salinity (ppt)	29-32	28-32 ^c
5.	Ammonia (mg/l)	0,023-0,19	<0,1 ppm ^b

Information :

a : Ghufroon *et al.*, (2017)

b : Arsad *et al.*, (2017)

c : Tibun *et al.*, (2015)

From these results, it can be seen that the water quality during rearing is still feasible for rearing Pacific white shrimp larvae (*L. vannamei*).

Discussion

Growth

According to the study's findings, replacing fish meal with sea worm meal (*Nereis* sp.) at different doses in each treatment had a significant effect on the growth of post larvae of vannamei shrimp (*L. vannamei*) reared for 42 days. Growth occurs as a result of changes in average weight during maintenance (Putri *et al.*, 2020). Tahe and Hidayat (2011), state that the availability of high-quality feed is an absolute requirement for shrimp growth and production. Several factors influence growth, including feed and water quality. The main factors that play a role in determining growth and survival are the nutritional content of feed (Herawati 2014). According to Pinandoyo *et al.*, (2016), efficient feed use will have a positive impact on production costs and water quality. Based on the statement of Aalimahmoudi *et al.*, (2016), the management of feeding, such as the time and frequency of feeding, is very influential on the growth of shrimp. Suitable water quality

conditions will support shrimp life. Shrimp growth performance is strongly influenced by water quality (Chen *et al.*, 2019).

The post larval growth of Pacific white shrimp (*L. vannamei*) that was reared showed good results. The doses of *Nereis* sp. flour used were in treatments A (0% *Nereis* sp. flour), B (25% *Nereis* sp. flour), C (30% *Nereis* sp. flour), and D (35% *Nereis* sp. flour). Based on the results of the proximate analysis, it was found that the protein content of each test feed contained (A) 42.95% protein, (B) 47.69%, (C) 48.78% and (D) 47.33%. The protein value in the test feed was able to meet the needs and support the growth of post-larvae Pacific white shrimp (*L. vannamei*). Protein requirements to support the growth and survival rate of Pacific white shrimp (*L. vannamei*) post larvae range from 30 – 50% (Yustianti *et al.*, 2013). The use of sea worm flour (*Nereis* sp.) as a substitute for fish meal in feed due to the high nutritional content of *Nereis* sp. flour is thought to be able to meet the nutritional needs of white shrimp (*L. vannamei*). According to Yuwono (2005), *Nereis* sp. contains protein and fat in amounts that can meet the nutritional needs of various species of shrimp. Hadiyanto (2013), stated that the abundant availability of marine worms has been widely used as fish feed for various types of shrimp.

According to the findings, the results had a significant effect ($P < 0.05$) on the measured variables. The results of the variables measured, which include TKP, RGR, EPP, FCR, and PER, are thought to be capable of providing optimal growth for post larvae of white shrimp. Optimal growth because the feed can meet the nutritional requirements of white shrimp (*L. vannamei*). Feeds with a high protein content can help shrimp grow (Li *et al.*, 2015). With a value of 61.11%, *Nereis* sp. flour was the main source of high protein in the test feed. Protein content of *Nereis* sp. flour. This is higher when compared to fish meal and maggot flour, where maggot flour has also been extensively researched as a substitute for fish meal in feed. According to Hernowo *et al.*, (2020), fish meal contains 45.70% protein. Herawati *et al.*, (2019), discovered that maggot flour has a protein

content of 44.88%. When compared to the protein content of sea worm flour (*Nereis* sp.), both of these protein contents are less valuable.

Protein and fat are two of the most important nutrients for shrimp. As a result, its continued existence is critical to the fish and shrimp feed industries (Kiron *et al.*, 2012). According to Pinandoyo *et al.*, (2014), the amount of basic food ingredients containing protein influences the level of essential amino acid balance. This is supported by Jin *et al.*, (2019), who state that shrimp feed containing balanced amino acids is required for good growth. Sea worm (*Nereis* sp.) has a high nutritional content, as evidenced by its protein, amino acids, and fatty acids. According to Yuwono (2005), the protein and fat content of sea worms (*Nereis* sp.) is sufficient to meet the needs of various shrimp species. Amino acids in *Nereis* sp. flour are better suited to shrimp needs, with high levels of methionine, phenylalanine, and lysine. These amino acids are known to act as chemoattractants, which means they can stimulate appetite and aid in shrimp growth. Linoleic acid, linolenic acid, stearic acid, and EPA are some of the fatty acids found in the sea worm (*Nereis* sp.) and are included in the fatty acids required by shrimp. On this basis, the flour *Nereis* sp. can optimize shrimp growth.

The results of the total feed consumption data (TKP) calculation show that the highest in treatment (C) is 80.61 grams and the lowest in treatment (A) is 75.21 grams. The amount of feed consumed each day during the study is referred to as the level of feed consumption (Hidayat *et al.*, 2014). The amount of feed consumed has a significant impact on the growth of white vaname shrimp. The higher the feed consumption, the more energy the shrimp body can produce. The energy will be used for shrimp metabolism and growth. This is supported by Coelho *et al.*, (2019), who state that the energy derived from feed consumption is used for metabolic processes and shrimp growth. According to Susanti *et al.*, (2015), high growth rates are influenced by high levels of feed consumption.

The level of feed consumption can be influenced by several factors, including the

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condition of the feed given. These include the level of feed palatability, size, smell, taste and color of feed. According to Abidin et al. (2015), the physical and chemical factors of feed such as palatability, taste, smell, and color of feed affect the level of feed consumption. The test feed given had the same size according to the mouth opening of the reared white shrimp (*L. vannamei*) larvae. The test feed was in the form of crumble with a slight difference in smell and color between the treatment feeds. In treatment A (0% *Nereis* sp. flour), it had smell like feed in general, but the smell was more intense and smelled like fish meal, besides that the color looked dark compared to treatment B (25% *Nereis* sp. flour) and C (30% *Nereis* sp. flour). This is presumably because feed A (0% *Nereis* sp. flour) has the highest composition of raw materials in fish meal. In treatment B (25% flour of *Nereis* sp.), C (30% flour of *Nereis* sp.) and D (35% flour of *Nereis* sp.) had a more pleasant smell than feed A (0% flour of *Nereis* sp.). The color in the treatment feed (B) and (C) was not as dark as in the feed (A) and (D). This is presumably because the feed (D) contains the largest composition of raw materials in *Nereis* sp. so that the feed (D) has a darker color. During the research, it can be seen that the shrimp's response to feed using *Nereis* sp. flour is very high. According to Yuwono (2005), worm flour contains the amino acids methionone, phenylalanine, and lysine, which act as chemo-attractants and can increase shrimp appetite. This statement is supported by Khasani (2013), that attractants are produced from free amino acids.

Based on the calculation of the relative growth rate (RGR) data, the highest value was obtained in the treatment with a dose of 30% *Nereis* sp. flour (C) ie 3.84%/day and the lowest was in the treatment with a dose of 0% *Nereis* sp. flour (A) is 2.78%/day. The growth rate shows the percentage of fish weight gain every day during the study (Rachmawati and Samidjan, 2013). The highest relative growth rate was treated with a dose of 30% *Nereis* sp. flour (C) became the best dose to support the growth of vaname shrimp larvae reared for 42 days. It is suspected that the post larvae of white shrimp (*L. vannamei*) that were reared were able to utilize the feed given well, where in treatment (C) was the best dose of the test feed. Factors that affect growth include feed, cultivar hereditary traits, and water quality (Manganang and Numisye, 2019). A high growth rate is followed by a high feed utilization efficiency value. This is

reinforced by the statement of Mukhlis et al., (2020), that feed efficiency is closely related to the average daily body weight gain and feed consumption.

High feed utilization efficiency (EPP) will result in high growth supported by suitable environmental conditions. This is reinforced by Simon et al., (2020), that growth increases due to the right feed composition and high feed intake rates. Feed utilization efficiency is the ratio between weight gain and the amount of feed given during the study. According to Taqwadasbriliani et al., (2013), the efficiency of feed utilization is the amount of feed used by the fish body. Based on the results of the calculation of the efficiency of feed utilization variables, it can be seen that the highest value is in treatment C (30% *Nereis* sp. flour) of 72.01%. It is suspected that the post larvae of vaname shrimp in this treatment were able to consume feed well. According to Isnawati et al., (2015), the use of efficient feed will result in a high efficiency value of feed utilization, so that the energy needs of the shrimp body can be met and the rest be used for growth.

The high growth value and feed utilization efficiency were followed by a low feed conversion ratio (FCR). This is reinforced by Dahlan et al., (2017), that the value of the feed conversion ratio is inversely proportional to weight gain, so the lower the value, the more efficient the shrimp are at utilizing the feed. Herawati et al., (2021), stated that the lower the FCR value, the more efficient the cultivation is at converting feed into energy sources. The value of the feed conversion ratio can be influenced by water quality. This is reinforced by Bachrudin et al., (2018), that feed conversion is a determinant component of growth and survival which is influenced by salinity and temperature. According to Pinandoyo et al., (2017), satiation feeding can reduce the risk of wasted feed so as to reduce FCR. Based on the results of the study, it was found that the lowest FCR value was in treatment C (30% *Nereis* sp. flour), which was 1.39% and the highest was in treatment A (0% *Nereis* sp. flour), which was 1.8%. This value is classified as good for vaname shrimp. This is in accordance with the statement of Bahri et al., (2020), that the value of a good feed conversion ratio for white shrimp is 1.3-1.4, which means that to get 1 kg of shrimp it takes 1.3-1.4 kg of feed. This is reinforced by Fahrizal and Nasir (2017), who state that feed conversion is the ability of cultivators to convert feed into meat.

Low feed conversion ratio results in high growth. Based on the results of the measurement of all variables, it is known that the highest growth was found in treatment C (30% *Nereis* sp. flour) and the lowest growth was in treatment A (0% *Nereis* sp. flour). Based on this, it can be said that the substitution of fish meal with *Nereis* sp. flour at a dose of 30% gave optimal growth in post larvae of white shrimp (*L. vannamei*) reared for 42 days. This research is compared with other studies that use maggot flour as a substitute for fish meal and with those that only use commercial feed. It can still be said that the post larval growth of white shrimp (*L. vannamei*) with feed using 30% *Nereis* sp. flour is superior managed to grow well and optimally. Based on the research of Herawati *et al.*, (2019), it is known that the growth of vaname shrimp on the use of maggot flour as a substitute for fish meal achieves the best growth at a dose of 16% maggot flour with a feed conversion ratio value of 1.85%. Research conducted by Hakim *et al.*, (2018), using commercial feed for vaname shrimp is known to have a feed conversion ratio value ranging from 1.6-2.49%. Based on this, the use of *Nereis* sp. flour is better to support the growth of white shrimp. This is because the sea worm flour (*Nereis* sp.) contains protein, amino acids, and high fatty acids, which are essential components that are important for shrimp growth. This is reinforced by Li *et al.*, (2015), that protein, amino acids, and lipids and fatty acids are important nutritional components in feed that are able to meet the nutritional needs of shrimp and increase growth.

High protein can support the growth of vaname shrimp. The effect of protein value on growth can be measured through the variable protein efficiency ratio (PER). The protein efficiency ratio is the percentage of protein weight in the feed given and used for growth (Hanief *et al.*, 2014). Based on the results of the study, it was found that the highest protein efficiency ratio value was in treatment C (30% *Nereis* sp. flour) which was 1.67% and the lowest was in treatment A (0% *Nereis* sp. flour), which was 1.30%. This is in accordance with the results of the proximate analysis of the protein content of the test feed, with the highest value in

treatment (C) which is 48.78% and the lowest in treatment (A) which is 42.95%. This value is in accordance with the protein requirements to support the growth and survival of the post larvae of vannamei shrimp (*L. vannamei*), which is 30-50% (Deslianti *et al.*, 2016; Herawati *et al.*, 2020). The high PER value indicates that the feed protein is of high quality and can support shrimp growth. Widyantoko *et al.*, (2015) support this by stating that the level of protein digestibility affects protein quality, with easily digestible protein indicating that the amount of amino acids absorbed by the body is higher, thus affecting growth. *Nereis* sp. flour also contains amino acids that meet the nutritional requirements of vaname shrimp. Shrimp can meet their essential amino acid requirements through feed consumption (Lee and Kyeong, 2018). According to Riyanti *et al.*, (2020), quality protein must have a high level of digestibility and an abundance of amino acids that are similar to the species being reared. Shrimp growth can be aided by amino acids such as glycine, alanine, proline, and taurine (Li *et al.*, 2015).

The high growth rate is influenced by the availability of feed energy which is used for growth. According to Resti *et al.*, (2021), that growth occurs if the need for feed for body maintenance has been met, where the feed energy is used for maintenance needs and the rest is for growth. Based on the calculation results, it can be seen that the energy values in each treatment are A (390.49 kcal/g), B (387.90 kcal/g), C (390.76 kcal/g) and D (391.17 kcal/g). The highest growth occurred in treatment C (30% *Nereis* sp. flour) and the lowest was in treatment A (0% *Nereis* sp. flour). The availability of sufficient feed energy supported by a balance of nutrients in the feed can support the growth of shrimp. The high growth in treatment C (30% *Nereis* sp. flour) was thought to be due to the maximum use of feed energy by shrimp for growth. This is supported by the high fat content in the feed, namely in treatments C (9.95%) and A (7.46%), so that the intake of energy needs for body maintenance does not use much protein, but is obtained from fat supported by carbohydrates. Fat is the largest source of

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energy after protein and carbohydrates (Marzuqi and Dewi, 2013). This is supported by the statement of Panini *et al.*, (2017), that the content of fat and fatty acids in feed greatly affects the level of digested energy in feed for growth.

Based on the energy value of the feed, it can be seen that the highest energy content was in treatment D (391.17 kcal/g) and the smallest was in treatment B (387.90 kcal/g). In treatment D, (35% *Nereis* sp. flour), there was too much energy. Availability of energy that is too high causes less than optimal growth because it is suspected that it can reduce the level of feed consumption which affects the low efficiency of feed utilization, thus causing a low growth rate with increasing feed conversion ratios and low protein efficiency ratio values due to less efficient protein for growth. This was confirmed by Aslamyiah and Muh (2013), who showed that the energy content of the feed is too high and causes reduced feed intake, so that acceptance of other nutrients, including protein for growth, is reduced. According to Munisa *et al.*, (2015), that feed energy affects feed consumption. Treatment B (25% *Nereis* sp. flour) had too low energy compared to other treatments. Based on the results of the calculation of the protein energy ratio with the results in each treatment, namely A (8.98); B (8.93); C (8.99) and D (9.00), it can be seen that the lowest yield was in treatment B (25% *Nereis* sp. flour), but the calculation results of TKP, RGR, EPP, FCR and PER data were higher than treatment A (0% *Nereis* sp. flour) and D (35% *Nereis* sp. flour). It is suspected that the shrimp in treatment B (25% *Nereis* sp. flour) were able to utilize non-protein energy sources for body maintenance well compared to treatments A (0% *Nereis* sp. flour) and D (35% *Nereis* sp. flour). This is evidenced by the fat content in treatment B (9.74%) was higher than treatment A (7.46%) and D (9.23%). The highest growth in treatment C (30% *Nereis* sp. flour) was suspected to be energy availability with balanced protein and non-protein energy sources that were sufficient to support shrimp growth properly. According to Tahapari and Jadmiko (2018), balanced feed protein energy plays a role in supporting growth.

Survival Rate (SR)

Based on the results of research, it can be seen that the survival value of post-larvae of white shrimp (*L. vannamei*) reared for 42 days reached the highest level in treatment C (30% *Nereis* sp. flour) and treatment D (35% *Nereis*

sp. flour), which was 100% and was followed by treatment B (25 % *Nereis* sp. flour) which was 98.89% and the lowest was in treatment A (0% *Nereis* sp. flour), which was 92.22%. According to Herawati *et al.*, (2020), the survival rate reaches 95%. It is believed that the feed contains high protein. This value is classified as good for survival. This is reinforced by Permanti *et al.*, (2017), that the survival rate is categorized as high if the SR value is > 70%, the medium category is for SR values of 50-60% and low for SR values of 50%. There are several factors that affect the survival rate of vaname shrimp post larvae. These factors include water quality, maintenance media and feed (Respati *et al.*, 2021). The shrimp that died in this study were due to cannibalism, which was thought to be due to the attack of healthy shrimp on shrimp that were weak due to molting. Cannibalism can arise due to the attack of healthy shrimp on weak shrimp after molting (Anita *et al.*, 2017).

Water Quality

Based on the results of research, we obtained water quality data on the maintenance media, where the parameters measured included temperature, pH, dissolved oxygen (DO), salinity, and ammonia. Indirectly, water quality affects the appetite of shrimp so that it affects the growth and survival of shrimp (Pinandoyo *et al.*, 2020). Based on the measurement results, it can be said that the water quality of the post larval rearing medium of white shrimp (*L. vannamei*) during 42 days of rearing is still within reasonable limits, so that it can support growth and survival. Water quality, according to Venkateswarlu *et al.* (2019), is critical to increasing shrimp culture production. This is consistent with the statement of Putri *et al.*, (2020), who state that good water quality also supports good metabolic and physiological processes. Feeding management affects water quality conditions, where the frequency of feeding affects growth and water quality. The frequency of feeding no more than 4 times per day can provide good growth and water quality (Aalimahmoudi *et al.*, 2016).

The temperature of the maintenance medium during the study ranged from 28.2-32.4°C. This value is still good enough to support the growth of Pacific white shrimp post larvae. According to Ghufroon *et al.*, (2017), the optimal temperature required for vaname shrimp ranges from 28-32°C. Gaona *et al.*, (2011), stated that white shrimp (*L. vannamei*) has a temperature

tolerance ranging from 15-35°C. Temperature is able to affect appetite, where if the temperature increases, then the level of feed consumption will increase, and if the temperature drops, then the appetite will decrease and the digestive and metabolic processes will slow down (Mulyani *et al.*, 2014). The next parameter is pH, where the pH value ranges from 7.41-8.3. This value is optimal to support the growth and survival of vaname shrimp. The optimal pH value for shrimp growth ranges from 7-8.5. Shrimp can tolerate pH values in the range of 6.5-9. A pH value that is below the tolerance range can disrupt the molting process, so that the skin becomes soft and cause low survival (Arsad *et al.*, 2017).

Another water quality parameter is dissolved oxygen (DO), as it is known that the DO value ranges from 3.89-5.67 mg/l. This value is good for supporting the growth and survival of vaname shrimp. This is in accordance with the statement of Dahlan *et al.*, (2017) that the dissolved oxygen value to support the life of white shrimp is > 3 mg/l. Salinity in rearing water ranged from 29-32 ppt. This value is in accordance with the feasibility of the salinity value to support the growth and life of vaname shrimp. According to Tibun *et al.*, (2015), the optimum salinity for vaname shrimp larvae ranged from 28-32 ppt. Vannamei shrimp have euryhaline properties that allow them to live at a salinity of 0.5-40 ppt (Febriani *et al.*, 2018).

The ammonia obtained from the measurement results at the beginning of maintenance was 0.023 mg/l and at the end of maintenance it was 0.19 mg/l. The value of ammonia is still within the tolerance limit of vaname shrimp, so it can still be said that it does not have a very bad effect on the growth and survival of vaname shrimp post larvae. This is reinforced by the opinion of Herawati *et al.*, (2019), which states that the ammonia value for shrimp must be lower than 1 ppm. This statement is supported by Perez *et al.*, (2013), that the total ammonia that can be tolerated by vaname shrimp is 0-1.0 mg/l. The high level of ammonia is caused by the accumulation of feed residues and feces at the bottom of the water, which can increase the content of toxic nitrite, causing

stunted growth and death (Arsad *et al.*, 2017). This can be overcome by siphoning that is carried out regularly and a continuous aeration system, so that the water quality remains stable and is still within a reasonable range (Pinandoyo *et al.*, 2016).

Conclusions

Conclusions

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

1. Substitution of fish meal with *Nereis* sp. flour had a significant effect ($P < 0.05$) on the growth of Pacific white shrimp post larvae (*L. vannamei*). The best dose with the highest growth rate was in treatment C (30% *Nereis* sp. flour) with TKP (80.61%), RGR (3.84%/day), EPP (72.01%), FCR (1.39%) and PER (1.67%). The lowest growth rate was found in treatment A (0% *Nereis* sp. flour) with TKP (75.21%), RGR (2.78%/day), EPP (55.94%), FCR (1.89%) and PER (1.30%).
2. Substitution of fish meal with *Nereis* sp. flour had a significant effect ($P < 0.05$) on the survival rate of Pacific white shrimp post larvae (*L. vannamei*). The best dose that achieved the highest survival rate was in treatment C (30% *Nereis* sp. flour) with a value of 100.00% and the lowest was in treatment A (0% *Nereis* sp. flour), which was 92.22%.

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