

Oxygen Consumption Rate of Polychaeta *Nereis* sp. Different Sizes and Type of Feed

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Abstract

Nereis sp. contains amino acids and unsaturated fatty acids that can improve the quality of gamete stem cells and the quality of the resulting larvae. *Nereis* sp. can increase gamete cell maturation in the parent shrimp up to 70%. This triggers the exploitation these worms excessively in nature since there are no cultivation efforts to meet their needs. This condition encourages research on the biological aspects of *Nereis* sp. to complement the information that can support the cultivation of the worms. This research was conducted on *Nereis* sp. from the Jeruklegi Cilacap area with different types of feed. This study aims to determine the metabolic rate of the worms *Nereis* sp. at different sizes by giving different types of feed. This research use immature *Nereis* sp. which was maintained at 15 ppt salinity with three different body weight (0.3-0.6 g; 1.1-1.3 g and 1.8-2.04 g) with three different types of feed (DO feed, feed flour of *Spirulina* sp. and ornamental fish feed tetra blitz). The study was conducted experimentally with a randomized block design (RBD) method with six replications. The results showed the rate of oxygen consumption of *Nereis* sp. influenced by the size and type of feed given ($P < 0.05$). *Nereis* sp. with size of 0.3-0.6 gr indicates the highest metabolic rate. *Nereis* sp. fed with flour of *Spirulina* sp. shows the highest metabolic rate. Appropriate feed to support the growth of *Nereis* sp. is DO and tetra blitz (low fiber feed).

Keywords: worms, feed, oxygen consumption, weight, *Nereis* sp.

Introduction

Nereis sp. is a member of Polychaeta, Nereidae, which live in the estuarine ecosystem as benthic but also actively swim in the waters when reproducing (Wallace et al., 1991). Wibowo et al. (2018) found the worms, *Nereis* sp., in Jeruklegi pond area of Cilacap in the water with salinity of 9-30 ppt, but live optimally at 5-15 ppt (Wibowo et al., 2019). In regard to food, these worms can digest the remains of plants and animals by swallowing the surface of sediments in the form of organic matter resulting from degradation from aerobic microbial and anaerobic processes in the form of proteins, cellulose, and lignin (Kristensen, 2000).

Worms *Nereis* sp. which is maintained at 15 ppt salinity, fed with the main content of animal protein and the main content of vegetable protein shows that the survival is not different with survival rate ranging from 60-70% (Wibowo et al., 2019). *Nereis* worms with zooplankton feed show faster growth compared with phytoplankton feed. These are thought to be due to better nutritional value of zooplankton. Zooplankton contains animal protein that is more easily ingested thus, not much energy is

needed for digestion and metabolism (Yuwono, 2003).

A feed is a factor that greatly influences the life and growth of *Nereis* sp. The growth of sea worms is closely related to the availability of protein in the feed because protein is a source of energy for sea worms (Mustofa, 2012). *Nereis* sp. with animal protein feed experienced higher body weight growth compared to plant protein feed (Wibowo et al., 2019). This condition is also possible because of *Nereis* sp. tends to be carnivores, so it is more suitable if fed with animal protein content. Appropriate food will be more easily metabolized, thus affecting the energy which will be issued.

Body size factors also affect the amount of energy needed to metabolize so that the rate of oxygen consumption will also be different. The rate of oxygen consumption depends on body size, digestive ability, and ambient temperature Cook et al., 2000). Schmidt-Nielsen (1990) states that measuring oxygen consumption is an easy and practical way to do it and is commonly used to measure metabolic rate. This is because the amount of heat produced per liter of oxygen consumption for metabolism is relatively constant

both for protein oxidation (4.5 kcal /l O₂), carbohydrates (5.0 kcal/l O₂), or fat (4.7 kcal/l O₂). The result is an average value of 4.8 kcal/l O₂, which can be used as a measure of metabolic rate.

This study aims to determine the rate of oxygen consumption of *Nereis* sp. At various sizes with different types of feed, so that it will provide information about the appropriate feed to support the life of polychaeta *Nereis* sp. on various sizes. The results of this study are expected to provide basic information regarding oxygen consumption for the culture of *Nereis* sp. as an effort to meet the needs of shrimp feed, so it does not rely on exploitation from nature.

Materials and Methods

Ingredients used worms *Nereis* sp. immature obtained from the Jeruklegi Cilacap pond area with a bodyweight of 0.3-0.6 g; 1.1-1.3 g and 1.8-2.04 g Jeruklegi Cilacap pond substrate, seawater, freshwater, DO feed, flour of *Spirulina* sp. and tetra blits (ornamental fish feed), MnSO₄ solution, KOH solution, concentrated H₂SO₄ solution, 0.025 N Na₂S₂O₃ solution, starch indicator, and distilled water.

Experimental design

The study was conducted experimentally with a randomized block design method (RBD) with the following treatments: PD0B1= Maintenance of worms *Nereis* sp. with a bodyweight of 0.3-0.6 gr and feed with DO. PD0B2=Maintenance of worms *Nereis* sp. with a bodyweight of 1.1-1.3 g and feed with DO. PD0B3=Maintenance of worms *Nereis* sp. with a bodyweight of 1.8-2.04 g and feed with DO. PSPB1 = Maintenance of worms *Nereis* sp. with a bodyweight of 0.3-0.6 gr and feed with flour of *Spirulina* sp. PSPB2=Maintenance of worms *Nereis* sp. with a bodyweight of 1.1-1.3 g and feed with flour of *Spirulina* sp. PSPB3=Maintenance of worms *Nereis* sp. with a bodyweight of 1.8-2.04 g and feed with flour of *Spirulina* sp. PTBB1=Maintenance of worms *Nereis* sp. with a bodyweight of 0.3-0.6 gr and feed with tetra blits (ornamental fish feed). PTBB2= Maintenance of worms *Nereis* sp. with a bodyweight of 1.1-1.3 gr and feed with tetra blits (ornamental fish feed). PTBB3 = maintenance of worms *Nereis* sp. with a bodyweight of 1.8-2.04 grams and feed with tetra blits (ornamental fish feed). Each treatment was provided six units as a repetition.

Preparation of culture media, the substrate was taken from the Jeruklegi Cilacap aquaculture area, then dried for 2 x 24 h. Sludge was put in a test container (20 x 30 cm) with a thickness of 5 cm.

Each treatment container was filled with a substrate with 15 ppt water salinity, with a water height of 15 cm, with aeration was then left for 1 (one) week. *Nereis* sp. were taken from the pond area of Jeruklegi Cilacap, Central Java and immature worms were selected (growth period when the morphology of males and females can not be distinguished, namely brownish red). It is placing test worms, each container filled with 10 worms *Nereis* sp. that had been acclimating for two weeks. The placement of the test worm is carried out after weighing its initial weight and separated according to its weight range. The study was conducted for two months, and each treatment was fed according to treatment, once a week as much as 2% of body weight.

Metabolism (oxygen consumption)

Observation of oxygen consumption parameters was carried out at the end of the study. Oxygen consumption was measured by a respirometer using the Winkler model Fry (1971) method in Brougher et al. (2005). The formula calculates dissolved oxygen according to APHA (2005).

Oxygen consumption (mg.g⁻¹.hour⁻¹) of worm measured using Fidhiany method (1999). Measurement of oxygen consumption is carried out at a water temperature of 25°C.

$$VO_2 = (c O_{2i} - c O_{2f}) \times V \times H^{-1} \times W^{-1}$$

Note : VO₂ = Oxygen consumption (mg.g⁻¹.h⁻¹); cO_{2i} = Initial dissolved oxygen (mg.L⁻¹); cO_{2f} = Final dissolved oxygen (mg.L⁻¹); W = Worm Weight (g); V = The volume of the tube after reducing the volume of worms (l); H = Time interval for initial and final oxygen measurements (hours).

The data obtained were analyzed statistically using two-way analysis (factorial) followed by Tukey test. The analysis was performed using the MINITAB 16 software program.

Results and Discussion

The observations showed that the average oxygen consumption rate of *Nereis* sp. in three different sizes and given three different types of feed ranging from 0.08812-0.56590 mg.g⁻¹.h⁻¹. The lowest oxygen consumption rate obtained in worms *Nereis* sp. size 1.8-2.04 g (large size) that is fed Do, and the highest rate of oxygen consumption is highest in worms of size 0.3-0.6 g (small size) with feed flour of *Spirulina* sp. The rate of oxygen consumption of the worms various body weights maintained with different feed at the end of the experiment (Table 2).

The results showed that feed and body size/body weight had a significant effect ($P < 0.05$) on the rate of oxygen consumption at the end of the experiment. Table 2 and Figure 1 show that the metabolic rate, in this case, the rate of oxygen consumption of the worms *Nereis* sp. influenced by the type of feed given. According to Schmidt-Nielsen (1990), oxygen consumption is a picture of direct energy use in metabolic work, including metabolism for the eating and living activities of an organism. These results confirm that the metabolic work of *Nereis* sp. influenced by the type of feed consumed, which is thought to be related to the composition of the feed and its degradation process.

The results showed that *Nereis* sp. with fed DO and tetra blits flour, which had a crude fiber content of 6.28% and 4.31% had the same oxygen consumption rate ($P > 0.05$) and significantly different with those fed flour of *Spirulina* sp. which has a crude fiber content of 14.76%. This result is following Wibowo *et al.* (2019), who showed *Nereis* sp., which are maintained at salinity of 5, 10 and 15 ppt, by being fed with protein animal-based diet have a lower metabolic rate than those fed with plant-based protein. This result is also consistent with the study of Yuwono *et al.* (2002) in juvenile helminths, which produced higher segment growth with animal protein feed (*Brachionus*) compared to vegetable protein (*Spirulina* and *Chlorella*). This condition occurs because the process of digestion of

feed, which contains more fiber, requires energy so that the rate of oxygen consumption becomes greater then growth becomes smaller. According to Ranjhan (1993) in Darmadi *et al.* (2003), fibrous food will increase the energy needed in the digestive process, so that energy that should be used to increase body tissue is expended for the process of digesting fibrous food. According to Cook *et al.* (2000), Zimmermann and Kunzmann (2001), oxygen consumption will be influenced by changes in the ability of digestibility of feed.

The results also showed the rate of oxygen consumption was influenced by body weight ($P < 0.05$). Oxygen consumption rate of *Nereis* sp. with a body weight of 0.3-0.6 g and 1.1-1.3 g greater when compared to *Nereis* sp. with a body weight of 1.8-2.04 g. These results indicate that *Nereis* sp. smaller ones have a higher metabolic rate or oxygen consumption rate. This phenomenon is following Sherwood *et al.* (2011), which states that larger animals consume more energy than small animals, but they have a lower metabolic rate than the weight of smaller animals. These results are following Liu *et al.* (2009), which shows that the rate of oxygen consumption of *N. japonica* worms is inversely proportional to body weight, where the smaller the body weight, the rate of oxygen consumption increases. This result is also in accordance with previous studies which showed the level of oxygen consumption and the rate of excretion of ammonia

Table 1. Proximate composition of feed

Feed	% water	% Dry wight	% Crude Fibre (%)				
			Protein	Fat	Fiber	Ash	Non-Nitrogen Extract Matter
Feed DO	7,91	92,09	31,74	9,69	6,28	7,91	44,38
Feed Tetra blits	7,11	92,89	39,53	7,07	4,31	7,11	41,99
Flour of <i>Spirulina</i> sp,	8,44	3,83	59,57	0,50	14,76	8,44	16,73

Table 2. Oxygen consumption rate ($\text{mg}\cdot\text{g}^{-1}\cdot\text{h}^{-1}$) of *Nereis* sp. with various sizes that are maintained with different feeds. Numbers followed by different letters in the same column show significant differences between treatments ($P < 0.05$).

No.	Treatment	Range	Average
1	PDOB1	0,23806 - 0,31508	0,25556±0,0312 ^b
2	PDOB2	0,15139 - 0,30279	0,22026±0,0561 ^b
3	PDOB3	0,04918 - 0,12296	0,08812±0,0251 ^c
4	PSPB1	0,30514 - 0,56590	0,40408±0,0978 ^a
5	PSPB2	0,28851 - 0,48207	0,36825±0,0817 ^a
6	PSPB3	0,08095 - 0,25635	0,18664±0,0529 ^d
7	PTBB1	0,23804 - 0,47159	0,31041±0,10582 ^{ab}
8	PTBB2	0,15140 - 0,37849	0,27177±0,08464 ^{ab}
9	PTBB3	0,04894 - 0,20800	0,13663±0,06585 ^{cd}

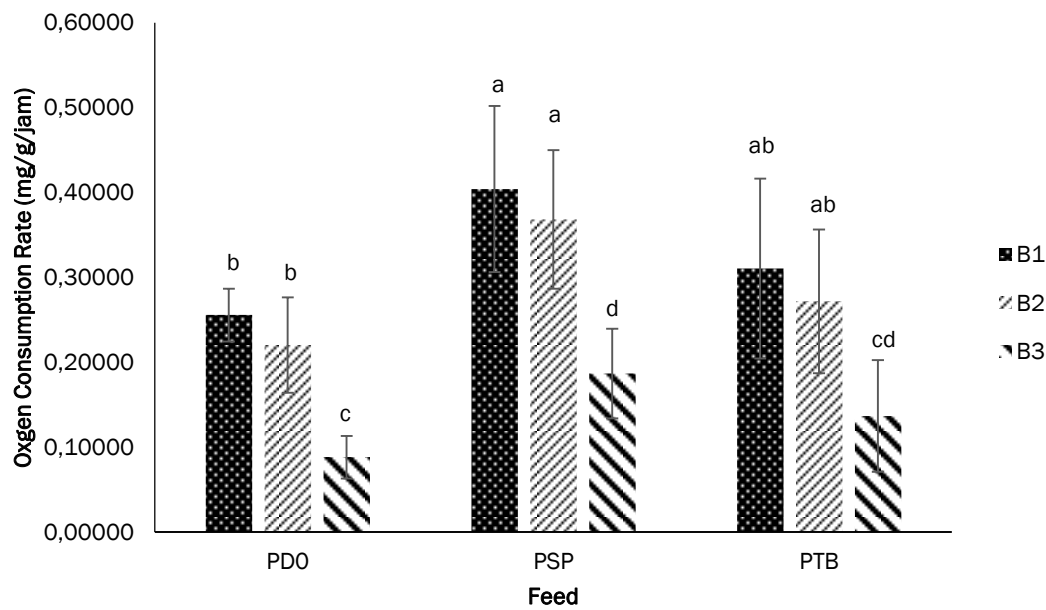


Figure 1. Oxygen consumption rate (\pm SD) of *Nereis* sp. with various sizes that are maintained with different feeds. Different letters on the bar chart show significant differences between treatments ($P < 0.05$)

from *N. japonica* calculated in weight loss units with weight gain, illustrating the universal principle that the metabolic rate per unit weight is often inversely related to body weight (Wu and Sun, 2006). The same phenomenon is also shown in the experiment of Karyawati *et al.* (2004) on sea cucumbers with smaller body weight also showed a greater rate of oxygen consumption. According to Yuwono (2008), the rate of oxygen consumption is influenced by several factors, including age, reproductive status, feed in the intestine, physiological stress, activity, season or ambient temperature, and body size.

Conclusion

The metabolic rate of worms *Nereis* sp. influenced the type of feed and body size. The highest metabolic rate occurs in *Nereis* sp. with small body weight and which are feed *Spirulina* sp. (which has a high fiber content). Appropriate feed to support the growth of *Nereis* sp. is DO and tetra bits (low fiber feed).

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