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Cultured sand sea cucumber growth with different water exchange systems

Pertumbuhan teripang pasir yang dibudidayakan dengan sistem pergantian air yang berbeda

Debora Victoria Liubana[1*], Joi Alfreddi Surbakti[2], Claudya Zyta Tobu[1]

[1]Defense Polytechnique, Indonesia Defense University
[2]Kupang Agricultural Polytechnique
*Corresponding author: debivictoria16@gmail.com

ABSTRACT

Sand sea cucumber (*Holothuria scabra*) is a high economic value as a food source. Sea cucumbers contain beneficial bioactive compounds for health. This study determined the sea cucumber growth cultured in an integrated multi-trophic aquaculture (IMTA) with different water exchange systems in Lifuleo waters from October to December, 2020. This study was performed in an experimental method with three different exchange system treatments and three replications, namely once every 2 days (tank A), every day (tank B), and water circulation every day (tank C). Briefly, sand sea cucumbers with 116.72 ± 117.91 g body weight and 11.06 ± 11.83 cm length were maintained for 45 days with different water exchange systems and fed with *Eucheuma cottonii*. The results showed that the best water exchange systems to increase sand sea cucumber production was tank A with 100% survival rate, 1.84 ± 0.06%/day specific growth rate, and 1714.96 ± 34.13 µm length growth rate. The water quality parameters were also optimal during the sand sea cucumber with the integrated system.

Keywords: Multi-trophic, growth, circulation, integrated system, sandfish

ABSTRAK

Teripang pasir (*Holothuria scabra*) mempunyai nilai ekonomis tinggi dan diperdagangkan sebagai bahan pangan. Selain itu teripang juga mengandung senyawa bioaktif yang bermanfaat untuk kesehatan. Penelitian ini mengkaji tentang pertumbuhan teripang yang dibudidayakan secara integrated multi-trophic aquaculture (IMTA) dengan sistem pergantian air yang berbeda di perairan Lifuleo pada bulan Oktober sampai Desember 2020. Penelitian ini dilakukan dengan metode eksperimental dengan tiga perlakuan 3 ulangan dengan sistem pergantian air 2 hari sekali (bak A), pergantian air setiap hari (bak B) dan sirkulasi air dilakukan setiap hari (bak C). Secara singkat, teripang dengan bobot badan 116.72 ± 117.91 gr dan panjang 11.06 ± 11.83 cm dipelihara selama 45 hari dengan sistem pergantian air dan diberi makan dengan *Eucheuma cottonii*. Hasil penelitian menunjukkan bahwa media perlakuan teripang dengan sistem pergantian air yang berbeda terbaik untuk meningkatkan produksi teripang adalah bak A dengan tingkat kelangsungan hidup 100, laju pertumbuhan spesifik harian 1.84 ± 0.06%/hari dan laju pertumbuhan panjang 1714.96 ± 34.13 µm. Parameter kualitas air juga menunjukkan kualitas yang optimal pada budidaya teripang secara terintegrasi.

Kata kunci: Multitropic, pertumbuhan, sirkulasi, terintegrasi, teripang pasir

INTRODUCTION

Sand sea cucumber (*Holothuria scabra*) is one of the sea cucumbers with high economical value and exploited commercially in tropical area, including Indonesia (Jasmadi, 2018). The sea cucumber distribution is extremely wide in several waters with 1–40 m depth (Matrutty *et al*., 2021). This sea cucumber lives in a shallow or an intertidal water habitat, besides in a deeper water with sea grass, sandy, and muddy substrates (Al Rashdi *et al*., 2012; Hamel *et al*., 2013; Purcell, 2012). Sea cucumbers have high protein content and are sold among Rp 400.000.00–1.200.000.00/kg as dried product (Tomatala *et al*., 2018a). In addition, sea cucumbers are one of the bioactive compound sources that can be beneficial for health (Albuntana *et al*., 2011).

Sea cucumbers that are relatively easy to find in a shallow water area cause these organisms are highly exploited in nature without noticing the size and age (overfishing). Moreover, the Echinodermata species such as sea cucumbers are a food source with various important nutrient values (Satria *et al*., 2014). Good stock management absence impacts on the low population in nature around the world that causes these species are included as endangered species in the IUCN Red-List of Threatened Species (Hamel *et al*., 2013). This condition encourages the culture activity with technological approach as an effort to support the population recovery and supply sea cucumbers with good quality and sustainability (Juinio-Menez *et al*., 2012).

Sand sea cucumber is a tropical sea cucumber type that can commonly be cultured (Purcell *et al*., 2014b). The culture system has many been developed, namely pen, pond, and floating-net cage cultures. Several countries have developed the sea cucumber culture, such as Australia, Philippines, Vietnam, Madagascar, Fiji, and Indonesia with various scales (Bowman, 2012; Duy, 2012; Firdaus *et al*., 2017; Hair *et al*., 2016; Juinio-Menez *et al*., 2012; Lavitra *et al*., 2010; Olavides *et al*., 2011). A good location site selection determines the culture activity success. Furthermore, the seed and feed supplies are key factors to support the culture development system and production.

IMTA system is an integrated-system that combines two or three culture commodities, whereas nutrient/feed waste from the high-level animal is consumed by the low-level animal to improve the growth rate. The IMTA system is applied to answer challenges about the culture activity issue on the aquatic environment that contains sedimentation and aquatic nutrient enrichment (Erlania & Radiarta, 2015; Alexander *et al*., 2016). The IMTA culture system is aimed to balance the ecosystem by rearing various species with different trophic levels that can improve the economic-added value and reduce the culture waste (Chopin *et al*., 2010; Yuniarsih *et al*., 2014). Studies regarding the IMTA system application have many been performed, namely: (1) nutrient utilization aspect from several culture commodities (Lander *et al*., 2013; Tang *et al*., 2015; Irisarri *et al*., 2015), (2) commodity productivity aspect (Neori *et al*., 2000; Erlania & Radiarta, 2015), and (3) social and economy aspects (Martinez-Espineira *et al*., 2015; Alexander *et al*., 2016).

MATERIALS AND METHODS

Location and Period

The study was conducted on October–December, 2020 for 45 days. This study was performed on a floating net cage system in Lifuleo waters, Kupang Barat Sub-district, Kupang District, East Nusa Tenggara.

Experimental design

This study was an experimental field with a completely randomized design with three different water exchange systems and three replications, namely:

Tank A: Sea cucumbers reared with water exchange once every 2 days

Tank B: Sea cucumbers reared with water exchange everyday

Tank C: Sea cucumbers reared with water circulation everyday

Equipment and Materials

The culture media used a floating-net cage equipped with wood block, board, plastic drum, nylon rope, drum-knotting rope, anchor rope, webbing, nail, saw, wood, wooden chisel, silicon glue, bolt, ring, carbide, anchor drum, threaded iron, anchor-welding, cement, sewing-needle, sewing-net, blinkers, battery, epoxy glue. For materials, sand sea cucumbers were used.

Seed stocking

The sea cucumber seeds as experimental organisms were obtained from the fishermen around Lifuleo waters. The sea cucumber seeds had 116.72 ± 117.91 g weight and 11.06 ± 11.83 cm length. Total number of seeds used was 225 sea cucumbers with the assumption that the pond carrying capacity for cucumber culture was 250 g/m^2, thus the stocking density was applied at 1 sea cucumber/m^2 (Agudo, 2012).

Sample collection

Sea cucumber seed sampling was performed once every 15 days. The samples were taken at 10 seeds from each treatment for length and weight measurements.

Water quality measurement

Water physical and chemical parameters observed during the experiment period included temperature, pH, and turbidity level. The measurement was performed every 7 days and accumulated every 15 days.

Parameters

Parameters observed contained survival rate (SR), specific growth rate (SGR), and length growth rate (LGR).

Survival rate

The survival rate was calculated with the following formula (Effendie, 1997):

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

Note:
SR = Survival rate (%)
No = Initial number of fish (fish)
Nt = Final number of fish (fish)

Specific growth rate

The specific growth rate was an individual weight growth in percentage that could be calculated using (Huisman, 1987):

$$SGR = \frac{\ln Wt - \ln Wo}{t} \times 100$$

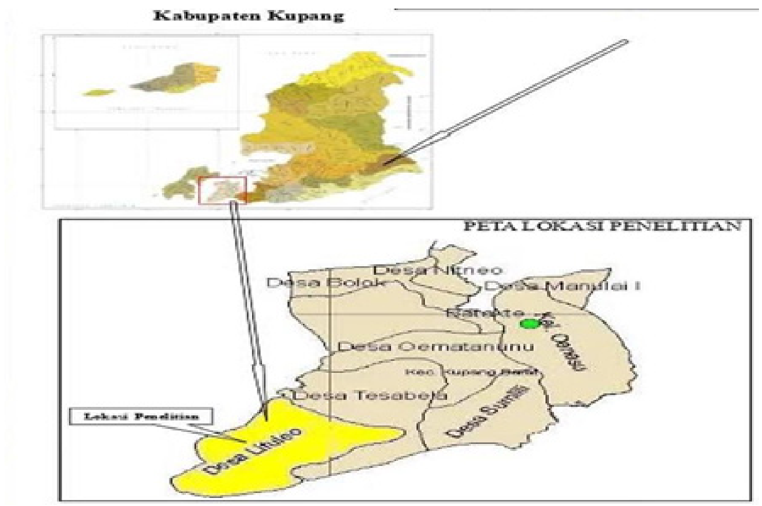

Figure 1. Location of sand sea cucumber (*H. scabra*) culture with IMTA system in Lifuleo waters.

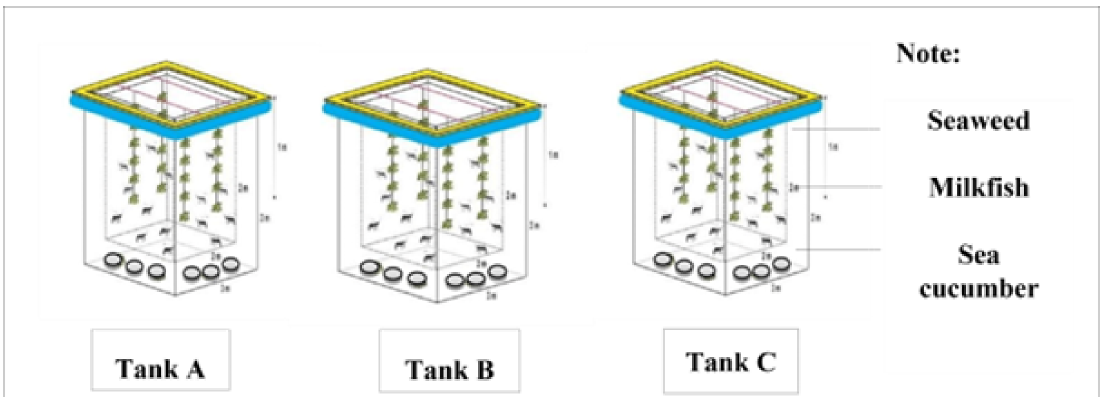

Figure 2. Rearing media design with sand sea cucumbers (*H. scabra*), milkfish (*Chanos chanos*), and seaweed (*Euchema cotonnii*) with IMTA system.

Note:
SGR = Specific growth rate (%/day)
Wo = Sea cucumber weight on initial rearing (g)
Wt = Sea cucumber on t-rearing period (g)
t = Rearing period

Length growth rate (LGR)

The length growth rate during rearing period was calculated using the formula (Allen *et al*., 2006):

$$LGR = \frac{(SLt - Slo)}{t} \times 10000$$

Note:
LGR = Length growth rate of sea cucumbers (µm/day)
SLt = Final sea cucumber length (cm)
SLo = Initial sea cucumber length (cm)
t = Rearing period (day)

Data analysis

The data collected in this study contained primary and secondary data. Primary data were collected through survey and direct measurement in the field. Survival rate, specific growth rate, length growth rate data were analyzed with an analysis of variance at 95% confidence level. If there was a significant different found among the data, the data were then analyzed using the Tukey test.

RESULTS AND DISCUSSIONS

Survival rate

The survival rate calculation results in sand sea cucumber (*H. scabra*) from three water exchange treatments with IMTA system for 45 days is presented in Figure 3.

Based on Figure 3, the survival rate data present the ideal condition in all treatments by reaching the value at 100%. Factors affecting the survival rate value are determined by feed quality and environmental condition (Purcell *et al*., 2012).

Specific growth rate (SGR)

Growth is length and weight increase in a certain period due to mitotic cell division (Spikadhara *et al*., 2012). The specific growth rate results in sand sea cucumbers from three water exchange treatments with IMTA system for 45 days of rearing period is presented in Figure 4.

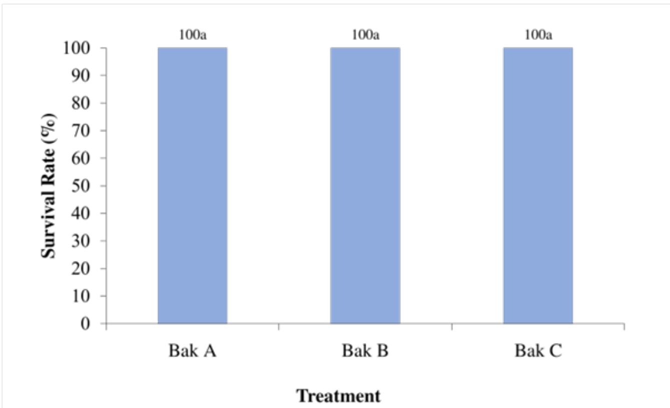

Figure 3. Survival rate of sand sea cucumber (*H. scabra*).

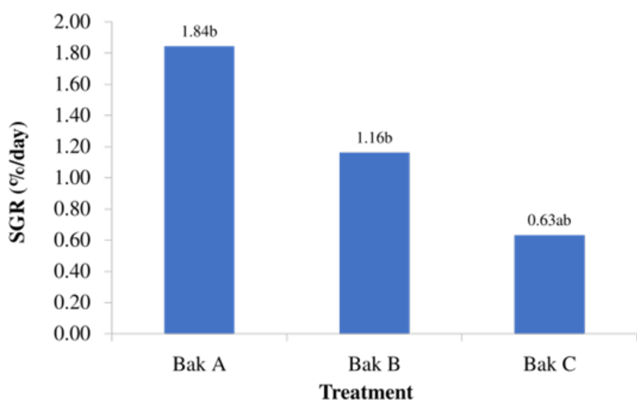

Figure 4. Specific growth rate of sand sea cucumbers (*H. scabra*).

Different water exchange treatments showed a significant different value on the specific growth of sand sea cucumbers ($p<0.05$). The highest specific growth rate value was obtained from the tank A at 1.84 ± 0.06%, while the lowest value was found in the tank C at 0.63 ± 0.05%. Soil substrate or texture is an extremely important component for organisms (Altamirano *et al*., 2017). Different specific growth rates on sand sea cucumbers were thought due to rare water circulation, which caused a higher substrate deposition on the tank base and promoted a higher growth rate in sea cucumbers.

Length growth rate (LGR)

Sea cucumber is one of the biota that lives spreading around the waters. This organism relatively lives on stagnant and clear waters. The habitat types that are mostly preferred by sea cucumbers are sandy mud, sea grass, and coral reef habitat (Kritsanapuntu *et al*., 2014). For fulfilling the culture management of sea cucumbers well, an aspect that should be noticed in culture activity is land suitability, before being used as a culture location. Also, the sea cucumber culture location should be free from pollution and fulfill the water quality standard for the cultured organisms.

Based on Figure 3, the calculation results of length growth rate obtained a significant different value ($p<0.05$). These results were similar to Kaenda *et al*. (2016). The highest length growth rate value was found in the tank A at 1714.96 ± 34.13 µm/day, while the lowest value was obtained from the tank C at 615.70 ± 5.71 µm/day. Low sea cucumber growth in tank C treatment (daily water circulation) was thought due to sediment condition that caused the sea cucumber stress.

Water quality

One of the aspects that should be noticed in performing the culture activities is land suitability for culture site, whereas sea cucumber culture should be free from pollution and fulfill the water quality standard for culture organisms. Temperature is a physical parameter that has a role in controlling the water ecological condition (Sithisak *et al*., 2013). Temperature fluctuation is highly determined by several factors, namely area height, rainfall, feed, and competitors or predators (Hartati *et al*., 2017). Temperature changes can commonly affect physical, chemical, and biological process occurred in the water column. Optimum water temperature range for sea cucumber seed rearing is 29–30°C with the salinity of 32–35 mg/l, and pH of 6.9–8.5 (Indriana *et al*., 2016; Indriana *et al*., 2017). Table 1 presents the temperature range in Lifuleo waters among 27.5–30.0°C, which were tolerable for sea cucumbers (Mazlan & Hashim, 2015).

pH indicates the acid and base condition

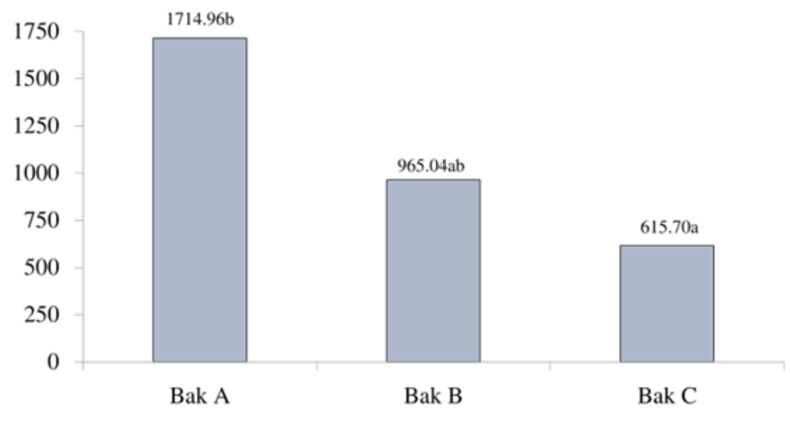

Figure 5. Length growth rate of sand sea cucumbers (*H. scabra*).

Table 1. Water quality parameter during sand sea cucumber (*H. scabra*) rearing.

	Tank		
Parameter	**A**	**B**	**C**
Temperature (°C)	27.50-30.00	28.00-31.50	27.00–30.00
pH	7.30-7.50	7.10-7.70	7.10-7.80
Turbidity (NTU)	2.80-3.10	2.50-2.80	1.80–2.50

balance (Nurussalam *et al*., 2017). pH < 7 (acid) can cause low dissolved oxygen consumption, while pH >7 (base) can cause increased ammonia (NH_3) level toxic for cultured organisms. Optimum pH range for sea cucumber seed rearing is 6.9–8.5 (Indriana *et al*., 2016; Indriana *et al*., 2017). The average measurement results of water pH level during the experiment period were 7.3–7.8. Sea cucumber can live in water with the pH of 6.5–8.2 (Mazlan & Hashim, 2015).

Turbidity describes the water optical characteristic that can be determined based on the amount of light absorbance and refraction by materials in the water. Turbidity occurs due to the existence of suspended and diluted organic and inorganic materials, such as mud and sand. The results showed the turbidity level in the three treatments were 1.80–3.10 NTU.

CONCLUSION

The development of sand sea cucumber (*H. scabra*) culture is highly possible in Lifuleo waters. Different water exchange treatments for sand sea cucumber culture with IMTA system provides a significant different on survival rate, specific growth rate, and length growth rate of the sea cucumbers.

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