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Short Communication

Assessing the Growth Performance of *Holothuria scabra* Juveniles in Concrete Tanks with a Diet of *Ulva lactuca*

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ABSTRACT

Managing density is critical in farming sandfish (*Holothuria scabra*), significantly affecting their growth and survival. Larval sandfish are initially reared in high-density fiber tanks, but as they develop into juveniles, they require larger and more spacious tanks to support growth. This study observes and analyzes the growth performance of *H. scabra* juveniles reared in concrete tanks with a diet of *Ulva lactuca*. Approximately 200 hatchery-produced sandfish juveniles, aged 40 days with a mean length of 1.03 ± 0.43 cm, were reared in Netlon cages (16 m^2) and placed in a large concrete tank with sandy sediment. They were fed weekly with 500 g of macroalgae *U. lactuca*. During the first 30 days, the juveniles showed slight growth to 3.20 ± 0.93 cm, further increasing to 4.82 ± 1.08 cm and 4.89 ± 1.13 cm at 60 and 90 days of rearing, respectively. The specific growth rate (SGR) calculated on day 90 was 1.75 ± 0.21% day^{-1}, and the survival rate recorded was 41%. In conclusion, the use of Netlon cages demonstrated positive results in sandfish growth and their suitability for sandy sediment conditions at the bottom of the tank, replicating their natural habitat. Additionally, the findings indicate that feeding sandfish with seaweed powder from the *U. lactuca* species contributes to improved growth.

Keywords: Holothuria scabra, juveniles, sandfish, *Ulva lactuca*

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INTRODUCTION

Holothuria scabra (*H. scabra*) (Jaeger, 1833) is generally known as sandfish (sea cucumber), which was listed as an endangered (EN) species under the International Union for Conservation of Nature (IUCN) Red List due to its declining wild stock in the natural habitat (Barclay et al., 2017; Han et al., 2016). The market prices of sea cucumber are slightly higher compared with other marine species because of demand and a limited number of wild stocks. Over the years, the increasing demand for high-market-value sea cucumbers has led to overexploitation in their natural habitat. Some cases of extinction have been reported in the original habitat (Wolfe & Byrne, 2022). Normally, sea cucumbers are popular for extraction and use as medicinal supplements, especially in Southeast Asia. It is believed that one of the nutritional benefits of sea cucumber is its ability to cure internal bleeding and improve health (Pangestuti & Arifin, 2018). There was a study that reported the presence of antimicrobial steroidal sapogenins in sandfish is an active agent that can actively fight against bacteria such as *Aeromonas hydrophila*, *Escherichia coli*, *Enterococcus* sp., *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Staphylococcus aureus*, *Vibrio harveyi*, and fish-borne mold, *Aspergillus* sp. (Adam et al., 2022; Nugroho et al., 2022).

Meanwhile, in Japan and China, sea cucumbers are a delicacy served as a luxury and exotic food, especially during festivals. The composition of sandfish that is high in protein content (43.23% to 48.27%) and low in fat (4.6% to 5.66%) makes it an option as an exotic food besides serving as a medicinal treatment (Rasyid et al., 2020). A culture technique for sea cucumber was introduced in Japan for the Stichopus japonicus to address the over-exploitation of sea cucumber and support its conservation (Imai et al., 1950). Later, the culture of sea cucumber was developed to other species from families of Holothuroidea and Stichopodidae, such as *H. scabra* (Militz et al., 2018), *H. fuscogilva* (Arriesgado et al., 2022), *Stichopus horrens* (Hu et al., 2013) and *Stichopus vastus* (Sulardiono et al., 2012), all of which were studied according to market value and demand. According to the Food and Agriculture Organization of the United Nations (FOA) (2018), the aquaculture world produced 130,000 metric tonnes of *Apostichopus japonicus*, which would increase to 205,000 metric tonnes in 2016. Increasing global production trends are one of the factors that increase the supply of sea cucumbers throughout the year to meet the supply-demand.

The nursing technique of sea cucumber is quite different from that of other marine species because of its life cycle. Preparing nursing sea cucumber seeds requires technology and some modifications for seed growth, depending on their life cycle phases. After the eggs are fertilized, they will self-develop to become larvae known as auricularia, with algae as their main food, such as *Isochrysis* sp. (Abdelaty et al., 2021), *Nannochloropsis* sp. and *Chaetoceros calcitrans* (Abidin et al., 2019). However, until today, the study of the culture of sea cucumbers is still in progress due to issues of low survival rate reported, especially at the metamorphosis and pentactula stages (Yu et al., 2022). Furthermore, there are some issues of grow-out and broodstock maturation: sea cucumber growth and declining weight when induced in a tank (Sembiring et al., 2018).

After the eggs fully hatch, the larvae auricularia swim in the water and undergo a metamorphic phase to transform from larvae to adults (pentactula) within 20–30 days. The newly adult pentactula sinks and attaches to the substrate in the tank to complete its development and transform to become a juvenile. Early rearing of larvae and juveniles is the most critical phase and requires a solution to address the issue of their low survival rate. The study of algae concentration fed on larvae was done by Militz et al. (2018), where it was reported that the larvae quality depended on the larvae concentration and water quality. Meanwhile, the study of food nutrition and rearing density was conducted by Lavitra et al. (2009), demonstrating that the extracts of *S. latifolium* provided the best survival rate for juveniles of sandfish, where the rearing density suggested is between 300 and 450 individuals m^{-2}. Recent research by Mahiyuddin et al. (2024) found that juveniles showed improved growth rates when reared at lower densities and fed *Spirulina*. Besides, a study of nursing was also carried out by Lavitra et al. (2015), showing that the high mortality was caused by the crab (predator), *Thalamita crenata*, where it was suggested to employ covered pens for protection against predators.

According to Rakotonjanahary et al. (2016), using marine sediment to nurse sandfish juveniles showed positive results during the study period. This study aims to obtain and observe the survival rate and growth performance of juvenile sandfish fed with *Ulva lactuca* in cages and the use of marine sediment at the bottom layers to create an environment similar to their natural habitat.

MATERIALS AND METHODS

Preparation for Concrete Tank

This study was conducted in a concrete nursery tank with a total area of a tank of 100 m² (10 m × 10 m) and a total volume of water of 40 tonnes. Netlon cage was set up in a tank with a total area of 16 m² (8 m × 2 m), where it was covered with marine sediment from the finest sediment and mud at a ratio of 50:50 at the bottom of the tank at 20 cm depth (Figure 1). The total height of the cage is 60 cm; 20 cm of the wall cage was planted at the bottom of the tank. The tank was covered with a 70% sunshade net.

Figure 1. The Netlon cage used for this experiment (8 m × 2 m)

Specific Growth Rate and Survival Rate with *Ulva lactuca* Diet

The juveniles of sandfish were produced by inducing the broodstock using the algae bath method. Meanwhile, these wild broodstock were collected from Desaru, Johor (southern part of Peninsular Malaysia). The larvae were reared in the tank until they developed into the juvenile stage, fed with *Chaetoceros* sp. Next, approximately 200 individuals of the same batch juveniles aged 40 days with a mean length of 1.03 ± 0.43 cm were collected and nursed in the tank, with a stocking density of 13 individuals per square meter. Water quality (salinity, alkalinity, temperature, ammonia, nitrate, and dissolved oxygen) was taken weekly, and the juveniles were fed weekly with seaweed powder *U. lactuca* at 31.25 gm^{-2} (500 g/week/cage). Water exchange in the tank was done every two days at 30% of the total volume. Sampling was done on the first week of every month by recording the different lengths of the sandfish juveniles. A number of 50 individuals were collected for every sampling session. At the end of this study, the specific growth rate (SGR) and survival rate (SR) of juvenile sandfish were estimated based on Indriana et al. (2017).

RESULTS AND DISCUSSION

Based on Table 1, the juveniles had a mean length of 1.03 ± 0.43 cm at the beginning of the experiment. After the first month (30th day) of rearing in a cage, the mean length of juveniles showed a threefold growth from the initial length to 3.2 ± 0.93 cm, with a specific growth rate of 3.83 ± 0.56% day^{-1}. Sampling for the second month (60th day) showed the mean length of juveniles increased four times from initial size to 4.82 ± 2.57 cm, where the specific growth rate is 2.58 ± 0.25% day^{-1}. The juveniles continued growing in the third month (90th day) (Figure 2) of rearing when the mean length reached 4.89 ± 1.13 cm, with a specific growth rate of 1.75 ± 0.21% day^{-1}. However, in the last month of the experiment (120th day of rearing), the mean length dropped to 3.40 ± 1.16 cm, and the specific growth rate also declined to 1.03 ± 0.12% day^{-1} across the rearing period. Based on the result, the highest mean length was recorded in the third month after the 90th day of rearing. Meanwhile, the best specific growth rate was recorded on the first month of rearing (30th day), which was 3.77% per day. The survival rate of epibenthic juveniles of sandfish in the cage declined by more than 50% across the rearing period.

Table 1
Survival rate, mean length (cm), and specific growth rate of juvenile sandfish

Rearing days	Mean length (cm)	Specific growth rate (%/day)	Survival rate (%)	Mortality rate (%)
0	1.03 ± 0.43	0		
30	3.20 ± 0.93	3.83 ± 0.56		
60	4.82 ± 1.08	2.58 ± 0.25		
90	4.89 ± 1.13	1.75 ± 0.21		
120	3.40 ± 1.16	1.03 ± 0.12	41	59

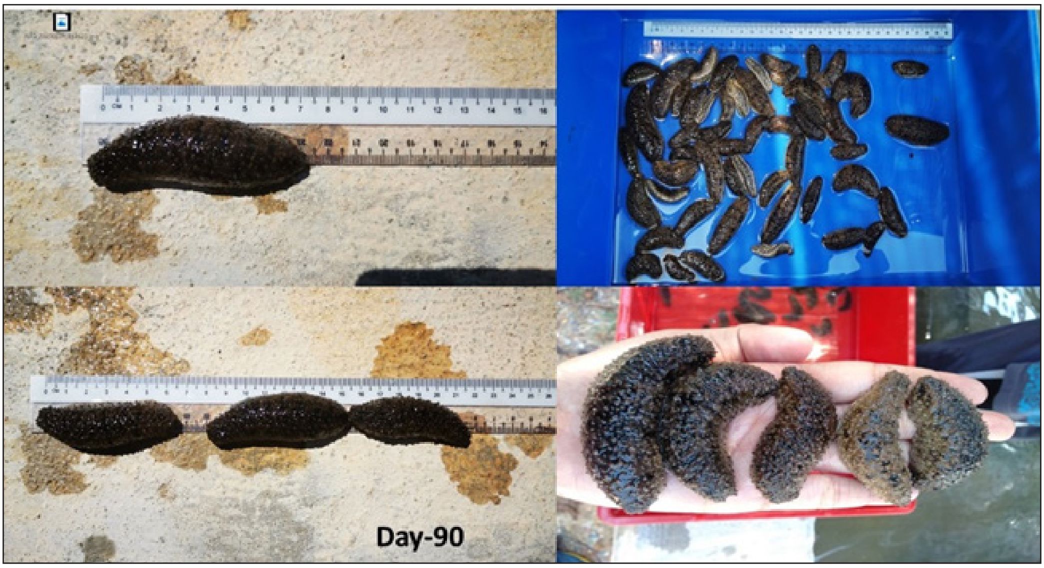

Figure 2. The increased size and length of juveniles on day 90 of rearing

The initial number of individual juveniles reared was 200 individuals. On the 120th day of rearing, the number of juveniles left was 82, with a survival rate and mortality rate of 41% and 59%, respectively. Based on Table 2, the average water parameter of the tank during the experiment was 31.4°C ± 1.9°C, where salinity was recorded at 31.53 ± 2.20 ppt due to dry season, alkalinity was at pH 8.10 ± 0.09, and dissolved oxygen was 4.47 ± 0.45 ppm. Meanwhile, the test for ammonia (NH_3) and nitrate (NO_2) were below 0.05 ppm. Generally, there are no wide variations or drastic changes in the water parameters or their rearing period.

Table 2
Water parameters along with the rearing period of sea cucumber Holothuria scabra

Parameter	**Mean ± SD**
Salinity (ppt)	31.53 ± 2.20
pH	8.10 ± 0.09
Temperature (°C)	31.40 ± 1.90
Ammonia	< 0.05
Nitrate	< 0.05
Dissolve oxygen (ppm)	4.47 ± 0.45

The result of the present study shows the survival rate is similar to the study of the effect of food quality and rearing density juveniles of sandfish by Lavitra et al. (2009), which was within 34% to 66% survival rate in an eight-week trial period, while the control test (without any artificial food supply) had dropped to 7% survival rate. Research for optimizing the growth of *H. scabra* juveniles during the nursery phase was done by (Rakotonjanahary et al., 2016), who reported that the use of marine sediment substrate and tilapia in co-culture resulted in better performance after seven weeks of rearing from an initial mean weight of 0.03 g to the highest weight of 9.01 ± 4.23 g in seven weeks. This suggested that rearing juveniles of sandfish requires an artificial diet and marine sediment to enhance the growth of juveniles.

According to Robinson et al. (2013), the study of the role of sand as substrate and dietary component for juvenile sea cucumber *H. scabra* was confirmed to have a positive effect on juvenile growth when sand is provided as a substrate; this is proven when the growth was observed to be positive, and the survival rate was 100% when sand was used as substrate in the tank, compared with sandfish reared in bare tanks. Based on the results and other studies, using marine sediment as substrate is necessary to provide similarity of its natural habitat and shelter for nursing the sandfish. The substrate at the bottom inhibits the sandfish from developing, completing its life cycle, and transforming into its final stage. Generally, adult sandfish have a special characteristic: the burying behavior based on the tank's feeding cycle and temperature conditions. Wolkenhauer (2008) demonstrated that the sandfish was active between 13:00 and 22:00 and became passive between 01:00 and 09:00, which is attributable to the temperature condition. It indicates that temperature was significantly and positively correlated to the sandfish feeding and burying behavior. Moreover, sandfish could act as bioremediation in the tank and sea pen by consuming unused organic deposits.

The positive growth performance was also supported by *Ulva lactuca* as the main food source for juveniles. Sandfish need to be fed artificial food in a controlled system to support their nutrient and protein requirements. A food test study by Lavitra et al. (2009) showed that sandfish fed with *Sargassum latifolium* resulted in the best growth rate of more than 50% compared with that when fed with *Thalassia hemprichii, Thalassodendron ciliatum, Syringodium isoetifolium*, and organic biofilm. From the present study's findings, sandfish can digest and absorb nutrients from seaweed after the seaweed is fully decomposed on the sediment. Normally, based on observation, seaweed requires 2–4 days to decompose and form a layer at the bottom. Furthermore, a study on feeding sandfish with seagrass *Cymodocea* sp. registered growth in length and weight (Arnull et al., 2021).

Lavitra et al.'s (2010) study reported that water temperature does not affect the survival of endobenthic sandfish. However, it predominantly affects their growth (high temperature > 30°C), which favors greater growth. However, sandfish are known to survive at 39°C; they turn weak when the temperature reaches 41°C and eventually die. Compared with water parameters in this study, the water temperature was slightly high at 31.4°C ± 1.9°C, which is a good range for promoting the growth of juveniles of sandfish. However, the declining growth performance after the 90th day of rearing may be attributable to the competition among sandfish juveniles with other marine organisms, such as gastropods, for food and space. Gastropods are widely found in tanks after three months of rearing, and their presence may affect the growth of juvenile sandfish, which needs further study.

CONCLUSION

Utilizing marine sediment as a substrate and incorporating *U. lactuca* into the diet of sandfish juveniles can significantly enhance their survival and growth. Sandfish juveniles at 0.5–1.0 cm sizes can be introduced to *U. lactuca* as an alternative diet when commercial seaweed powders, such as *Sargassum*, are unavailable. Furthermore, in-tank sandfish farming offers a more robust solution compared to pen culture in addressing the challenges posed by climate change, ensuring a more sustainable and resilient aquaculture practice.

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