Preliminary evaluation of seaweed of *Ulva lactuca* as supplemental diet for sea cucumber, *Holothuria scabra*, in aquaculture

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Abstract

The seaweed *Ulva lactuca* was evaluated as a food supplement for sea cucumber *Holothuria scabra*. The aim of this study was to examine the relationship between forms/texture of feed, ingestion rate and feces production rate of *H. scabra*. Ten individuals of *H. scabra* were placed in ten 20 L glass aquariums with continuous aeration. The sea cucumbers were divided into two groups: Group A (A1, A2, A3, A4, and A5) and Group B (B1, B2, B3, B4, and B5). The average initial weight of sea cucumber in Group A was 387.46 g (±2.33 g) while in Group B was 383.74 g (±3.56 g). Group A sea cucumbers were fed with 2.5 g of raw (natural form) *U. lactuca*, while Group B were fed with 2.5 g blended (mechanically shredded) *U. lactuca*. The ingestion rate (IR) for Group A was 0.01 g ind^{-1} d^{-1} (±0.02 g ind^{-1} d^{-1}) while Group B was 0.33 g ind^{-1} d^{-1} (±0.08 g ind^{-1} d^{-1}). The fecal production rate (FPR) for Group A was 0.05 g ind^{-1} d^{-1} (±0.01 g ind^{-1} d^{-1}) and Group B was 0.11 g ind^{-1} d^{-1} (±0.03 g ind^{-1} d^{-1}). From this study, it can be concluded that feeding *H. scabra* with blended form of *U. lactuca* seaweed has the most potential to be utilised as supplemental feed.

Keywords: feed, sustainable aquaculture, Holothurian

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Introduction

The tropical holothurian or sea cucumbers such as sandfish (*Holothuria scabra*), is one of the promising products for mariculture in the Indo-Pacific region (Battaglene, 1999; Bell *et al*., 2005; Hamel *et al.,* 2001). For more than two centuries, this valuable sea cucumber has been harvested and turned into dried products known as “beche-de-mer”, largely to supply demand from the Chinese market. However, overfishing, poor fisheries management, and increased market demand for “beche-de-mer” products have all contributed to a sharp fall in sea cucumber populations in recent decades (Anderson *et al*., 2001; Purcell *et al*., 2013). As a result, aquaculture has been proposed as a solution to the decline of wild sea cucumbers through restocking programme (Tolon *et al.,* 2016).

According to Rasyid *et al*. (2017), *Ulva lactuca* possessed high nutritional value and is also suitable for human consumption. The major nutrition components includes carbohydrate (58.1 %), moisture (16.9 %), ash (11.2 %), protein (13.6 %), fat (0.19 %), and dietary fibre (28.4 %) respectively. In order to increase ingredient varieties and as an alternative to the high price of dietary algae, *Spirulina*, which is conventionally used in sea cucumber formulated diets, this study assesses the seaweed *U. lactuca* as supplemental diet for sea cucumber in aquaculture. However, very little is known about the feeding habits of sea cucumbers in captivity (Sun *et al*., 2015). Most sea cucumbers are epibenthic and foraging on the seabed (Mohsen and Yang, 2021). It is apparent that all sea cucumbers rely on their tentacles to obtain food. Different species of sea cucumber may possess different types of tentacles; thus the feeding strategy may vary (Hudson *et al.,* 2005). This is essential for future planning of the formulated diet to enhance the efficiency of the diet made, as well as to ensure the animals are fed properly. Moreover, supplying nutritional feed to sea cucumbers is a crucial part of improving their growth performance (Tan, 2021). The objective of this study is to examine the relationship between different forms of *U. lactuca* as feed, ingestion rate and feces production rate of *H. scabra.*

Materials and methods

Animals and housing

Ten individuals of sea cucumbers (*H. scabra*) from the hatchery of Centre for Marine and Coastal Studies (CEMACS) were used in this study. They were randomly chosen based on their size visually and their wet weights ranging between 65 to 85 g each. The sea cucumbers then were divided into two groups, namely Group A (A1, A2, A3, A4, and A5) with an average wet body weight of 387.46 g (±2.38 g) and Group B (B1, B2, B3, B4, and B5) with an average wet body weight of 383.74 g (±2.14 g). Each individual was then placed into 20 L (30 x 15 x 20 cm) glass aquarium and equipped with continuous aeration. All sea cucumbers were starved for 24 hours to empty their gut contents.

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Experimental conditions

The physical conditions (temperature, dissolved oxygen, salinity, and pH level) of the experiment were monitored daily using YSI multiprobes. For this study, the sea cucumbers were fed with seaweed *U. lactuca* in two different forms. Group A was fed with 2.5 g of raw *U. lactuca* in their natural form, where the strands are long and tangled. While Group B was fed with 2.5 g of *U. lactuca* fragments where the strands are short and tangle-free achieved by blitzing the seaweed in a kitchen grade blender. The feeding trial was conducted for 3 days and feeding diet was given at 11:00 am each.

Tentacle movement

Sea cucumbers were observed as soon as feed was provided. Photographs and short videos of the tentacle's movements were captured with an Olympus TG5 camera during feeding. This approach was also used to determine the type of sea cucumber tentacles being observed in this study.

Feeding and ingestion rate

Following feeding, feces produced, and leftover seaweed were observed and recorded on the next day before they were siphoned out and collected separately. To obtain the dry weight, both feces and leftover seaweed were rinsed with fresh water to eliminate salt content and oven-dried at 52°C overnight. Weight of dried feces (Wdf), weight of dried leftover seaweed (Wls), and dry seaweed weight (Wfo) were determined by oven drying the samples (n=5) at 52ºC overnight. Lastly, the dried weight of food consumed (Wfc) was obtained by the difference of Wfo–Wls. To calculate the ingestion rate (IR), Equation 1 was used, while to obtain the feces production ratio (FPR), Equation 2 was used. The formula involved is based on Zamora and Jeffs (Zamora and Jeffs, 2012):

$$\text{IR (g ind}^{-1}\text{ d}^{-1}) = \frac{\text{Wfc/N}}{\text{t}} \quad \text{(Equation 1)}$$

Where IR is ingestion rate, Wfc is weight of food consumed, N is the number of sea cucumber in each tank, and t is the experimental duration in day.

$$\text{FPR (g ind}^{-1}\text{ d}^{-1}) = \frac{\text{Wdf/N}}{\text{t}} \quad \text{(Equation 2)}$$

Where FPR is fecal production ratio, Wdf is weight of dried feces, N is the number of sea cucumber in each tank, and t is the experimental duration in day.

Results and discussion

Experimental conditions

Physical parameters of the seawater were monitored for 3 days during the experimental period as shown in Table 1 above. This is to ensure the results of feeding trial observation are solely based on the feeding diet only.

Table 1*:* Physical parameters value during the experimental period of 3 days (n=18, ±SEM).

Parameters	Average value
Temperature (°C)	27.00 (±0.29)
Dissolved oxygen (%)	84.80 (±1.90)
Dissolved oxygen (mg/L)	5.54 (±0.14)
Salinity (ppt)	34.09 (±0.10)
pH level	8.32 (±0.00)

Tentacle locomotion

The peltate tentacles of *H. scabra* are shorter and stout compared to similarly

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peltate type tentacles of other sea cucumber such as *Holothuria leucospilota*. The blended seaweed fragments were small and short, thus, easier for the sea cucumber in Group B to grasp it using their short peltate tentacles and feed on it. While sea cucumbers in Group A seems to be unable to feed on the raw natural form *U. lactuca* due to their long strands (Fig. 1).

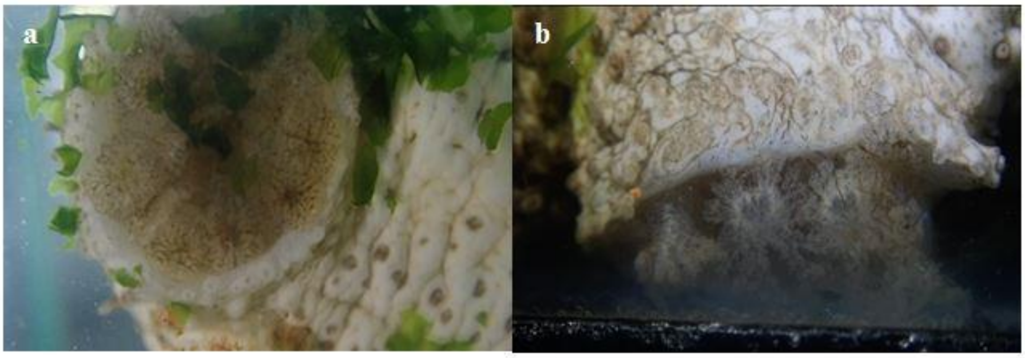

Figure 1*:* Sea cucumber, *Holothuria scabra,* oral part (a) Ventral view of the tentacles surrounding the oral opening. (b) Side view of the tentacle.

Ingestion rate (IR) and feces production ratio (FPR)

The Group B Sea cucumbers were feeding actively (mean IR=0.33 g ind^{-1}d^{-1}) when compared to Group A (mean IR=0.01 g ind^{-1}d^{-1}), whereby feeding barely occurred (Fig. 2).

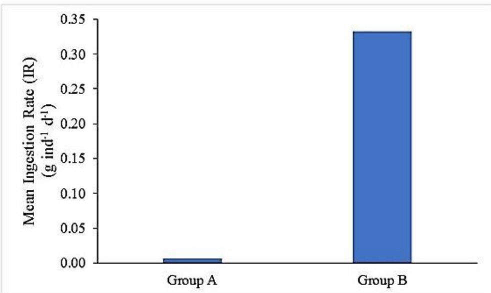

Figure 2: Mean ingestion rate (IR) of sea cucumber *Holothuria scabra* observed for 3 days. Group A (n=5) was fed with raw *Ulva lactuca*, while Group B (n=5) was fed with fragments of *U. lactuca*

Sea cucumbers from Group B have been observed to produce multiple strands of feces (mean FPR=0.33 g ind^{-1}d^{-1}) containing the blended seaweed, making the feces strands visually green in color.

Although some feces were produced by sea cucumber from Group A (mean FPR=0.05 g ind^{-1}d^{-1}), examination under the microscope revealed that the feces did not consist of the experimental seaweed diet (Fig. 3).

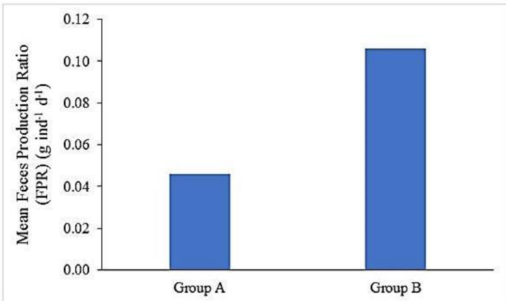

Figure 3: Mean feces production ratio (FPR) of sea cucumber *Holothuria scabra* observed for 3 days. Group A (n=5) was fed with raw *Ulva lactuca*, while Group B (n=5) was fed with fragments of *U. lactuca*

Parts of broken shells, materials such as sand grains, and small bits of rocks were found in the feces, all of which reflected on the substrates in their holding tanks

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which may have been consumed prior to this feeding observation period. This happened due to the slower rate of gut clearance. Hence, it is suggested to have 48 hours starvation period instead of 24 hours in order for all the gut content to be entirely removed before starting the experiment in the future experiment. Nevertheless, this experiment was a short observation to evaluate the potential of the seaweed diet to be utilized for sea cucumber supplementary feed. The sea cucumbers in our hatchery are fed with a paste-type of formulated diets daily. From Table 2, it is noteworthy to mention that the blended form of *U. lactuca* was easily accepted and consumed by the *H. scabra* as their diet.

Table 2: Mean ingestion rate (IR) and mean feces production ratio (FPR) of sea cucumber *Holothuria scabra* observed for 3 days. Group A (n=5) was fed with raw *Ulva lactuca*, while Group B (n=5) was fed with fragments of *U. lactuca*.

Group	IR ($g\ ind^{-1}\ d^{-1}$)	FPR ($g\ ind^{-1}\ d^{-1}$)
A	0.01 ±0.02	0.05 ±0.01
B	0.33 ±0.08	0.11 ±0.03

This suggests that blended seaweed could be potentially good supplemental food for sea cucumber to increase diet variation in cultivation. Further study using different types of seaweeds or mixed diets such as sea mud (*Xia et al*., 2012), benthic matters (*Gao et al*., 2011), or animal waste such as from shrimps and mussels (Zamora and Jeffs, 2012) can be taken into consideration in the future.

Conclusion

Blended *U. lactuca* seaweed has the potential to be utilised as supplemental feeding for the sea cucumber *H. scabra*, according to this study. Longer duration of study is recommended in the future to obtain a greater understanding of the physiology and growth rate of sea cucumbers fed with supplemental seaweed diets.

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