# Application of the bag method in the cultivation of seaweed *Sargassum* sp. at different water depths

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**Abstract**. The seaweed *Sargassum* sp. is easily damaged, especially in the fronds. This is one of the obstacles to its cultivation. This imposed the investigation of the use of the bag method to reduce this risk. The cultivation of *Sargassum* by the bag method and the investigation of its placement at several depths helps with information on appropriate methods for developing its cultivation. This study aims to determine the depth of water that provides the best growth for the seaweed using bags at multiple depths and the mesh bag method. The survey was conducted in the coastal waters of Kastela, in the Ternate Island district of Ternate City, Indonesia. The survey period was two months, from August to September 2021. The bag method was repeated 3 times at different water depths, at 0.5 m (A), 1 m (B) and 1.5 m (C). The data analyzed were absolute weight gain and relative growth rates. The results showed that the absolute weight gain of *Sargassum* in treatment A had the highest average absolute weight gain of 26.9 g, in treatment B it was 31.8 g, and in treatment C it was 25.9 g. Treatment B provided the highest absolute weight gain for *Sargassum*. The highest relative growth value of *Sargassum* was in treatment B, with an average value of 1.093%, followed by treatments A and B.
**Key Words**: absolute growth rate, coastal waters, Kastela, relative growth rate, Ternate city.

**Introduction**. One of the seaweeds with important economic value is *Sargassum* sp. *Sargassum* contains bioactive compounds that can be used as extracts or as main components in the food and pharmaceutical industries. Polysaccharides can be isolated from brown algae species, especially alginates and fucoidans (Prasanthi et al 2020). Alginates are widely extracted and used in the food, medical, and industrial processes as gelling and stabilizers (Redmon et al 2014).

In general, *Sargassum* is not widely known and used in Indonesia compared to other types of seaweed that are more popular. *Sargassum* is still obtained naturally, by collecting algae are generally in the form polysaccharides, namely alginate from the wild. The limited technology for cultivating *Sargassum* with the right method causes its production to be under par (Brown et al 2014). *Sargassum* is easy to be deteriorated, especially on the blade-like thallus, this being one of the obstacles faced in its cultivation efforts. This gave rise to the idea of studying the application of the bag method to reduce this risk. The study of *Sargassum* cultivation with the bag method and its placement at several depth levels may provide a suitable method for developing *Sargassum* cultivation (Muslimin & Sari 2017).

In North Maluku Province, there is potential for farming *Sargassum* in marine waters, but efforts to develop its cultivation have not been sustained until now. This is due to the lack of scientific information related to the existence of this species of seaweed. To recognize and utilize the existing potential, it is necessary to develop its cultivation through various technological innovations to increase its production. This research was conducted to determine the growth of *Sargassum* cultivated with the bag method at several levels of water depth, as well as determining the depth of water that provides the best growth for *Sargassum* with the net bag method.

## Material and Method

***Place and time of research***. This research was conducted in Kastela coastal waters, Ternate Island District, Ternate City, Indonesia. The research period was two months, from August to September 2021.

***Research container preparation***. The research containers used were bags of seaweed made in the form of a tube with a diameter of 25 cm and a height of 50 cm. *Sargassum* was weighed, and an initial weight of 50 g per clump were used in each treatment. The seaweed was then tied to the bottom of the bag facing up. This position is similar to the natural position of *Sargassum* attached to the substrate in its natural habitat. The seaweeds used were collected from nearby natural waters with some of the substrate still attached. The structure for *Sargassum* cultivation is rectangular, measuring 25x10 m, with a mesh size of 1.5 inches made of polyethylene rope anchored with concrete anchors. In the cultivation construction, two stretches of ropes are replicated in this study. Each stretch rope is installed with a distance of 2 m.

***Placement of the cultivation container***. The containers with the bags for *Sargassum* were placed at different water depths, at 0.5 m (treatment A), 1 m (treatment B), and 1.5 m (treatment C), with three replications.

***Observations***. Observations of the weight gain of *Sargassum* in each treatment were recorded. The condition of the environmental parameters of the waters was observed once a week. The environmental parameters observed included temperature, current velocity, pH, salinity, and dissolved oxygen. Measurement of temperature, pH, salinity and dissolved oxygen was carried out using a Horiba water checker, while the current velocity was measured using a float and a stopwatch.

***Data analysis***. The data analyzed were absolute weight growth data, which was obtained from the difference between the average weight at the end of rearing and the initial weight when stocked/planted, and the relative growth rate. To calculate absolute weight growth, the following formula (Amin et al 2005) was used:

$$W = Wt - Wo$$

Where: W - absolute weight growth (g); Wt - final weight (g); Wo - initial weight (g). To calculate the relative growth rate, the formula from Munoz et al (2004) was used:

$$SGR = Ln(Wt - Wo)/t \times 100$$

Where: SGR - growth rate (%); Wo - wet weight of *Sargassum* at the beginning of the study (g); Wt - *Sargassum* wet weight at the end of the study (g); t - maintenance time (45 days).

The design used in this study was a completely randomized design (CRD). The analysis of variance was used to determine if differences exist among treatments (Steel & Torrie 1980). However, no post-hoc test was used, as the differences in this study were not found to be significant.

## Results and Discussion

***Absolute weight growth***. The results of the analysis of the average absolute weight growth of *Sargassum* are presented in Table 1. Table 1 shows that the absolute weight growth of *Sargassum* has an average that varies in each treatment, namely treatment A with 26.9 g, treatment B with 31.8 g, and treatment C with 25.9 g. From these values, treatment B (water depth of 1 m) gave the best absolute weight growth for *Sargassum*, followed by treatment A (water depth of 0.5 m) and treatment C (water depth of 1.5 m).

To see the difference in the effect of each treatment on the absolute weight growth of *Sargassum*, an analysis of variance was carried out with the results presented in Table 2.

Table 1

Growth of absolute weight (g) of *Sargassum*

| *Test* | *Treatment* | | | *Amount* |
|---|---|---|---|---|
| | A | B | C | |
| 1 | 29.2 | 33.1 | 28.3 | 90.6 |
| 2 | 23.4 | 33.4 | 27.3 | 84.1 |
| 3 | 28.1 | 29.1 | 22.1 | 79.3 |
| Total | 80.7 | 95.6 | 77.7 | 254 |
| Average | 26.9 | 31.8 | 25.9 | |
| SD | ±5.18 | ±5.63 | ±5.08 | |

Table 2

Results of variance analysis of absolute weight growth variations of *Sargassum*

| *Source of diversity* | *Degrees of freedom* | *Sum of squares* | *Middle squares* | *F count* | *F table* 0.05 | *F table* 0.01 |
|---|---|---|---|---|---|---|
| Treatment | 2 | 0.061 | 0.0305 | 1.163[ns] | 5.14 | 10.32 |
| Error | 6 | 5.240.56 | 2.620.2805 | | | |
| Total | 8 | | | | | |

Note: ns - not significant.

The results of the analysis of variance in Table 2 show that the calculated F value (1.1639) is lower than the F table 0.05 and 0.01 values, so the effect is not significantly different on the absolute weight growth of *Sargassum*, or, in other words, the different depth had no significant effect on the absolute weight growth of *Sargassum* cultivated using the net bag method.

***Relative growth***. Relative growth is the result of the difference between the final average weight and the initial average weight divided by the time of rearing seaweed multiplied by one hundred percent. The results of the analysis of the relative growth of seaweed *Sargassum* sp are presented in the Table 3.

Table 3

Average relative growth (%) of *Sargassum*

| *Test* | *Treatment* | | | *Amount* |
|---|---|---|---|---|
| | *A* | *B* | *C* | |
| 1 | 1.02 | 1.128 | 0.995 | 3.143 |
| 2 | 0.851 | 1.135 | 0.966 | 2.952 |
| 3 | 0.988 | 1.017 | 0.813 | 2.818 |
| Total | 2.859 | 3.28 | 2.774 | 8.913 |
| Average | 0.953 | 1.093 | 0.924 | |
| SD | ±0.976 | ±1.045 | ±0.961 | |

Table 3 shows that the relative growth value of *Sargassum* varies. Treatment B produced the highest average relative growth value of 1.09%, followed by treatments A and C. To determine if the differences are significant, the analysis of variance was performed with the results presented in Table 4.

Table 4

Results of the analysis of relative growth varieties of seaweed *Sargassum* sp

| *Source of diversity* | *Degrees of freedom* | *Sum of squares* | *Middle squares* | *F count* | *F table 0.05* | *F table 0.01* |
|---|---|---|---|---|---|---|
| Treatment | 2 | 0.049 | 0.0245 | $3.356^{ns}$ | 5.14 | 10.32 |
| Error | 6 | 0.044 | 0.0073 | | | |
| Total | 8 | | | | | |

Note: ns - not significant.

The results of the analysis of variance show that the calculated F value (3.356) is lower than the F table 0.05 and 0.01 values, so the treatments effect is not significantly different regarding the relative growth of *Sargassum*, or, in other words, different water depths do not significantly affect the relative growth of *Sargassum* cultivated using the net bag method.

***Water quality***. The results of observations of water quality parameters during the study are presented in Table 5.

Table 5

Water quality during research

| *Parameter* | *Range* |
|---|---|
| Temperature (°C) | 26.7-32.2 |
| Current speed (cm $sec^{-1}$) | 20-25 |
| pH | 6.9-7.2 |
| Salinity (‰) | 30-32 |
| Dissolved oxygen (ppm) | 4-5 |

***Absolute weight growth and relative growth***. The difference in absolute weight growth value of *Sargassum* in different water depths was not much different. The water quality in the cultivation site, especially temperature, salinity, and current speed are supportive of seagrass growth. The high absolute weight growth of seaweed *Sargassum* at a water depth of 1 m is due to the proper penetration of sunlight, enabling the seaweed to carry out the photosynthesis process properly. In addition, the availability of nutrients in these water is considered good in supporting the growth of seaweed. On the other hand, at deeper waters (1.5 m), the absorption of sunlight is reduced, which results in decreased growth due to less photosynthesis. Wars & Kunto (2011) stated that photosynthesis is closely related to light intensity. The intensity of sunlight will decrease with the depth of the water layer. According to Muslimin & Sari (2017), the absorption of sunlight is one of the limiting factors for seaweed growth, so the depth factor is important to consider in the application of *Sargassum* cultivation. An increase in light intensity will always be followed by an increase in the productivity value of photosynthetic organisms to an optimum point (Alianto et al 2008). Another factor that is thought to affect the absolute weight growth of *Sargassum* is the size of the net bag, which is in accordance with the large mesh size (more than 1 cm), causing the supply of nutrients to enter and leave through the gap of the net bag freely, supporting growth (Muslimin & Sari 2017). In general, the relative growth range of *Sargassum* at each water depth ranged from 0.92 to 1.09%.

***Water quality***. The temperature in seaweed cultivation plays an important role for metabolic processes, the metabolism being more active in warmer water (Thana et al 1993). Temperature influences the physiological functions of seaweed such as photosynthesis, respiration, growth, and reproduction (Dawes 1995). For the maintenance of seaweed, water temperatures ranging from 20-32ºC (De San 2012) or a shorter range of 27-30ºC (Farid 2008) are needed. Increased temperature causes symptoms of yellowish and pale colors of unhealthy seaweed (Dawes 1995). A decrease in water temperature to 20ºC will decrease the growth of seaweed (Qian et al 1996). Fauziah (2017) stated that *Sargassum* can grow well if the water temperature is in the range of 25-33ºC. In *Sargassum* cultivation, the desired temperature is in the range of 25-30ºC (Muslimin & Sari 2017). The water temperature obtained in the study ranged from 26.7-32.2ºC, so it was supportive of the growth of *Sargassum*.

Current velocity plays a role in cleaning seaweed from adhering dirt (Insan et al 2013). Sufficient water movement will prevent the accumulation of impurities in the thallus, aid ventilation, and prevent large fluctuations in salinity and water temperature (Thana et al 1993). The current velocity in the range of 20-40 cm $s^{-1}$ is considered good for seaweed cultivation. Current velocities of more than 40 cm $s^{-1}$ can damage the construction of cultivation containers and break seaweed branches (Ariyati et al 2007). The results of current velocity measurements during the study ranged from 20-25 cm $s^{-1}$. Thus, the current velocity obtained in this study is supports the growth of *Sargassum* cultivated with the net bag method.

The pH is a factor that affects aquatic plant life. Cultured seaweeds have different adaptations to pH values (Irfan & Subur 2022). The measured pH is between 6.9-7.2. The growth of *Sargassum* can be observed in pH ranging from 6 to 9 (Irfan & Subur 2021). The pH obtained during the study ranged from 6.9 to 7.2, in a suitable range for *Sargassum*.

According to Fauziah (2017), the suitable salinity for *Sargassum* cultivation ranges from 25-32‰. The salinity level obtained is 30-32‰, so it is suitable to support the growth of *Sargassum*.

DO is a limiting factor for aquatic biota and determines growth and activity level (Karna 2003). The source of oxygen in the waters comes from the diffusion process from free air and the results of photosynthesis of biota that live in the waters (Nugroho 2006). DO is used by aquatic organisms for growth and reproduction (Lobban & Harrison 1997). DO with a range of 3-8 ppm, and >4 ppm, supports the good growth of seaweed (Ariyati et al 2007; Pongmasak et al 2010). The DO content obtained during the study was 4-5 ppm, making it suitable for the survival and growth of *Sargassum*.

**Conclusions**. The application of the floating net bag method at different depths of the water gave no significant effect on the absolute weight growth and relative growth of *Sargassum*. However, the water depth of 1 m gave the best results on absolute weight growth and relative growth of seaweed *Sargassum*.

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**Conflict of Interest.** The authors declare that there is no conflict of interest.

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