# Propagation of *Eucheuma spp*. (Agar-agar) Using Vertical Hanging Rope Method in Open Water Cultivation

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**Abstract.** The study aimed to determine the increase in length and number of fronds of *Euchema* spp. after cultivation using vertical hanging rope culture method. Five (5) fronds of *Eucheuma* spp. were inserted in an individual mesh bags tied 12 inches away from each other in a rope. A total of 25 sets of ropes were used in this study. The physico-chemical parameters (temperature, salinity and pH) of water in Sinunuc Bay, Zamboanga City, Western Mindanao, Philippines were analyzed. The increase in length and number of fronds were recorded daily for 45 days. Results showed that the 3 physico-chemical parameters were in the highly suitable ranged for seaweed farming. The mesh bags tied and exposed near the water surface produce higher longer fronds. This study will provide alternative methods in cultivating highly valued *Euchema* spp. to further increase the production and provide alternative livelihood and income to local fisherfolks.

**Keywords:** *Euchema* spp., vertical hanging rope culture method, fronds

**Introduction:** Seaweed farming or Seaweed agriculture is the practice of cultivating and harvesting seaweed (Hurtado 2013). Seaweed farming provides an important source of livelihood to families living in the coastal areas. Seaweeds or benthic marine algae are the group of plants that live either in marine or brackish water environment. The seaweeds contain photosynthetic pigments and with the help of sunlight and nutrient present in the seawater, they photosynthesize and produce food (Verlacar *et al.* 2004). It is an important component of the marine environment along with the mangroves and coral reefs. Seaweed are harvested worldwide primarily for the extraction of chemicals that serve as gelling and thickening agents in foods, and for media used in medical and microbiological work.

Humans have carried out the culture of seaweeds for hundreds of years and it is well developed in several Asian countries (Neori *et al.* 2004). Nowadays, cultured seaweeds represent most of the seaweed production, which is about 10 million tons fresh weight worldwide (Lüning and Pang 2003).

Production of seaweeds has greatly increased worldwide, from 1.995 million tons of fresh weight seaweeds in 1970 to 19 million tons in 2010 to meet the demands for phycocolloid production, food and the emerging seaweed based pharmaceutical, nutraceutical and biofuel industries.

The Philippines seaweed is highly diversified among the flora in Asia Pacific regions. More than 800 species of seaweeds have been recorded in the Philippines. The Philippines is one of the top producers of seaweeds in the world, and aquatic plants next to Indonesia (FAO 2007). Seaweeds are exported either in raw forms (fresh or dried seaweeds) or processed forms (semirefined chips/carrageenan and refined carrageenan).

In the Philippines, the different species cultured and collected are *Euchema*, *Gracilaria* and *Caulerpa*. The most popular and commercially cultured species is the *Euchema* sp. because it is easy to cultivate and due to fast growing characteristics and high market place (BFAR).

According to Narvaez 2015, Mindanao area contributes about 57 percent of the national seaweed production. Zamboanga Peninsula rank third of the top five producing regions, contributing 13 percent of seaweeds.

*Eucheuma* locally known as “agar-agar” was found abundant in the Philippines, particularly in the province of Tawi-Tawi, Sulu and Zamboanga City. These seaweeds are the most common and fast growing species in the Philippines and are found from just below the low tide mark to the upper subtidal zone of the reef, growing usually on sandy-corally to rocky substrata where water movement is

slow to moderate (FAO 2009). It became a source of livelihood among the people living in the coastal areas especially in Region 9 and Autonomous Region for Muslim Mindanao (Kalbi 2002).
Global concern has been rising regarding the impact of climate change on seaweed abundance, distribution and quality (Straub *et al.* 2016) and due to increasing demand for the dried seaweeds in both local and international markets. There is still a need to link strongly the institutional research and development to the problems and concerns of the seaweed farmers, especially on production and productivity (Hurtado 2013). Hence, a new technique of culturing *Euchema* spp. should be implemented to further increase the production and productivity of the said species and an effective technique that is also convenient to the local farmers and to the environment. With this, researchers would want to conduct a study on cultivation of *Eucheuma* spp. using vertical hanging rope culture method.

**Materials and Methods**

*Research design.* The *Eucheuma* spp. culture rafts were placed along the coast of Sinunuc, Zamboanga City Bay. The site is selected because it is moderately sheltered to the dominant wave regimes, providing some protection to the culture units.
*Preparation of Cultivation.* A total of 25 culture ropes were secured to a bamboo stick or plastic pipe (2 m long). The stick or pipe was suspended 0.5m below the sea surface from two to four (2-4) empty water bottles and was being fixed in position on the seabed by two concrete anchor weights or stones. Polyethylene ropes were used for growing the fronds of *Eucheuma* sp. contained in an individual mesh bags, there were five (5) mesh bags in each rope. A second bamboo stick at the bottom keeping all the ropes in place avoiding rope twisting.
*Collection of Stock Material.* Fresh *Eucheuma* spp. were bought from Zamboanga Public Market, Zamboanga City. Only fronds free from epiphytes and dark-green in color was being selected for cultivation. The fronds were kept in a submersed mesh bags in the sea before cultivation.
*Cultivation Experiment.* The culture period was done approximately for 45 days and the cultures were being checked and monitored daily. The 5 fronds of *Eucheuma* spp. were inserted in an individual mesh bags tied in the 25 individual ropes. The initial length and number of fronds were recorded before cultivation as well as the physico-chemical parameters of the site. Frond length and numbers was being monitored for 45 days.

**Results**

Table 1 revealed that the mesh bag 1 has the highest total increase in the length of the fronds (4.3 cm) *Eucheuma* spp. after 45 days.

Table 1. Total increase in length per bag of *Eucheuma* spp. after 45 days of experimentation.

| | | | | | total increase in length (cm) |
|---|---|---|---|---|---|
| R1B1 | R2B1 | R3B1 | R4B1 | R5B1 | 4.3 |
| 0.4 | 0.7 | 1.1 | 0.7 | 1.4 | |
| R1B2 | R2B2 | R3B2 | R4B2 | R5B2 | 2.8 |
| 0.2 | 0.5 | 0.8 | 0.4 | 0.9 | |
| R1B3 | R2B3 | R3B3 | R4B3 | R5B3 | 1.9 |
| 0 | 0.2 | 0.9 | 0.2 | 0.6 | |
| R1B4 | R2B4 | R3B4 | R4B4 | R5B4 | 0.7 |
| 0 | 0 | 0.5 | 0 | 0.2 | |
| R1B5 | R2B5 | R3B5 | R4B5 | R5B5 | 0.5 |
| 0 | 0 | 0.3 | 0 | 0.2 | |

Legend: R = replicate; B = mesh bag

Table 2 shows that the mesh bag 1 has the highest total increase in number of fronds (8), followed by mesh bag 2, mesh bag 4, mesh bag 3, and mesh bag 5 has the lowest number of fronds of *Eucheuma* spp. after 45 days of experimentation.

Table 2. Total increase in number of fronds per bag number of each ropes of *Eucheuma* spp. after 45 days of cultivation.

| | | | | | total increase in # of fronds |
|---|---|---|---|---|---|
| R1B1 | R2B1 | R3B1 | R4B1 | R5B1 | 8 |

| | | | | | |
|---|---|---|---|---|---|
| 2 | 3 | 1 | 2 | 0 | |
| R1B2 | R2B2 | R3B2 | R4B2 | R5B2 | 7 |
| 1 | 1 | 2 | 2 | 1 | |
| R1B3 | R2B3 | R3B3 | R4B3 | R5B3 | 4 |
| 1 | 1 | 1 | 1 | 0 | |
| R1B4 | R2B4 | R3B4 | R4B4 | R5B4 | 7 |
| 0 | 1 | 2 | 2 | 2 | |
| R1B5 | R2B5 | R3B5 | R4B5 | R5B5 | 1 |
| 0 | 0 | 0 | 1 | 0 | |

Legend: R = replicate; B = mesh bag

The paired sample test revealed that there was a highly significant difference ($p = 0.000$) between the initial length and final length of *Euchema* spp. after 45 days of experimentation at $\alpha = 0.05$ level of significance (Table 3).

Table 3. Paired Sample Test on the length of *Euchema* spp. after 45 days of experimention.

| Paired Samples Test | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Paired Differences | | | t | df | Sig. (2-tailed) |
| | | Mean | Std. Deviation | Std. Error Mean | | | |
| Pair 2 | final length - initial length | 0.41 | 0.39 | 0.08 | 5.18 | 24 | 0.000 |

Paired Sample Test shows that there was a highly significant difference ($p = 0.000$) in the initial and final number of fronds of the *Euchema* spp. after 45 days of experimentation (Table 4).

Table 4. Paired Samples Test on the number of fronds.

| **Paired Samples Test** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Paired Differences | | | t | df | Sig. (2-tailed) |
| | | Mean | Std. Deviation | Std. Error Mean | | | |
| Pair 1 | final fronds - Initial fronds | 1.080 | 0.862 | 0.172 | 6.263 | 24 | 0.000 |

**Discussion.** This study was conducted along the coast of Sinunuc, Zamboanga City Bay for 45 days. A Vertical Hanging Rope Method was used in the study and the physico-chemical parameters were determined. According to Gednet (*et al.*1982) that ecological parameters are the most important factor in the cultivation of *Echeuma* spp. These ecological parameters are water movement, salinity, depth, pH, light intensity and temperature.

Seaweed has a tolerance at a temperature of 24-36 $^{0}$C (Gros 1992 in Patajai, 2017). According to Dawes (1981), temperatures affect some physiological functions of seaweed, such as photosynthesis, respiration, metabolism, growth, and reproduction and the optimum salinity for seaweed cultivation of *Eucheuma* spp. or *K. alvarezii* is at salinity of 33 ppm (Israel *et al*. 2010). Too high or too low salinity will cause disruption to the physiological process of seaweed (Heriansah *et al.* 2017). In this study, the physico-chemical parameters were within the ranged suitable growth of seaweeds. The temperature of seawater during the study ranged from 30$^{0}$C to 37$^{0}$C, salinity from 25 to 33 % and pH from 7.8 to 7.9. All these 3 parameters were the highly suitable range for seaweed farming. Initial length of *Eucheuma* spp. fragments were recorded as well as the number of its fronds before it was cultivated for 45 days. The result of the study shows an increase in length and number of fronds in mesh bag 1. The result showed that the fragments that are nearly exposed to the surface have the most significant increase in length as well as to the number of fronds after 45 days of experimentation. This is due to the environment which is optimal condition for seaweed growth such as sunlight, water movement and depth. Seaweed obtains its nutrients for growth from the water and water movement is a very important factor for the growth of the seaweed. Moderate water movement is preferable; this also helps to stabilize water temperature and salinity. The direct association between water movement and nutrient absorption should be pointed out. In fact, Ryder *et al.* (2004) demonstrated that the lack of water movement significantly decreases growth rates of *Gracilaria parvispora.*

**Conclusion.** Preliminary field open sea culture of *Eucheuma* spp. using vegetative fragments inserted between braids of ropes suspended vertically inside a floating cage was under taken to assess the growth rate and yield as influenced by five different spacing intervals. The result showed that the fragments that are nearly exposed to the surface have the most significant increase in length as well as to the number of fronds developed after 45 days of experimentation.

**Recommendation.** It is necessary to conduct the same research on different location and to include other parameters such as Nitrate and Phosphate Test. Further studies are needed to refine the cultivation technique for increased production of *Eucheuma* spp. in the Philippines.

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