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THE UTILIZATION OF *Halymenia durvillaei* TO SUPPORT THE MANAGEMENT OF *Eucheuma spinosum* SEAWEED FARMING IN GEGER COASTAL AREA, BALI

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ABSTRACT

Seaweed farming activity is now facing some problems caused by pest fish herbivore and *ice-ice disease*. To solve those and improve our seaweed quality, seaweed production management requires some ecological technique improvements. The purpose of this study was to determine the functions of seaweed *H. durvillaei* for improving the production of the seaweed *E. spinosum* in the coastal area of Geger Beach, Peminge Village, South Kuta subdistrict, Badung regency, Bali. The measured data includes parameter of weight, length and water quality. Data was measured every 10 days for up to 40 days. The best growth result was shown by the model of *E. spinosum* that were fenced by *H. durvillaei* of 456 g for *E. spinosum*. *H. durvillaei* showed good impact on increasing the production of *E. spinosum* up to 68.7% compared to the control. Water quality conditions on seaweed culture was good with temperature ranged from 27.7 to 30.1°C, salinity from 30 to 32.3 ppt, DO from 3.9 to 5.5 ppm, pH from 7.9 to 8.4, current 0.1 to 0.2 m/s, and clearness of 100%.

Keywords: E. spinosum, H. durvillaei, Water Quality, Seaweed.

INTISARI

Pengelolaan produksi rumput laut memerlukan perbaikan-perbaikan secara ekologi karena belakangan ini kegiatan budidaya rumput laut sering mengalami kendala akibat adanya hama ikan herbifora dan penyakit *ice-ice*. Tujuan dari penelitian ini adalah untuk mengetahui peran rumput laut *H. durvillaei* dalam memperbaiki pengelolaan produksi rumput laut *E. spinosum* di Perairan Pantai Geger, Desa Peminge, Kecamatan Kuta Selatan, Kabupaten Badung-Bali. Data yang diambil meliputi data berat, panjang dan data kualitas air sebagai pendukung. Pengambilan data dilakukan setiap 10 hari selama 40 hari. Pertumbuhan yang paling baik diperlihatkan oleh model *E. spinosum* yang dipagari *H. durvillaei* sebesar 456 g. *H. durvillaei* berperan dalam meningkatkan produksi *E. spinosum* sebesar 68,7% jika dibandingkan dengan kontrol. Kondisi kualitas air tergolong sesuai peruntukan budidaya rumput laut dengan kisaran suhu 27,7-30,1 ^{o}C, salinitas 30,0-32,3 ppt, DO 3,9-5,5 ppm, pH 7,9-8,4, arus 0,1-0,2 m/s, dan kecerahan 100%.

Kata Kunci: E. spinosum, H. durvillaei, Kualitas Air, Rumput Laut

BACKGROUND

Management of seaweed farming requires ecological improvement for the recent decline in the quality or quantity which has influence on the revenues of seaweed farmers. In addition, in the development of coastal communities, the government is currently holding seaweed culture through the revitalization program. This revitalization program is determined because seaweed has some advantages such as wide open export opportunities, irreplaceable commodity because there is no synthetic product, stable prices no quota of commerce and simple cultivation technique. Another advantages of seaweed farming short cultivation cycle small capital requirements, and can create jobs for labor, as well as other uses for human life (Nursyahran, 2013).

Seaweed has either directly or indirectly function. Directly seaweed provide food for fish and invertebrates, especially young *thallus* (Mann, 1982), while indirectly as main sources for producing jelly, alginate and carrageenan and widely used in the food industry, cosmetics, pharmaceuticals and other industries such as the paper industry, textiles, photography, pasta and canned fish (Abdan, 2013). One of the productive area for cultivated *E. spinosum* seaweed is in the waters of Geger Beach, Peminge Village, South Kuta. Seaweed cultivation in this area encountered some obstacles, such the emergence of weeds, *ice-ice* disease, and the presence of pest fish herbivore (Arthana *et al*., 2015).

Instead of *E. spinosum*, another seaweed species *H. durvillaei* has also been cultivated. However, the species has not widely known yet by the community. This species has some advantages including higher resistances to disease, not liked by fish and grow more quickly. Based on those advantages the combining cultivation of *E. spinosum* premised by *H. durvillaei* was investigated. This study assuming that *H. durvillaei* are able to protect the species *E. spinosum* of from weeds and herbivorous fish pests attack.

The purpose of this study was to determine the role of seaweed *H. durvillae* in improving the production of seaweed *E. spinosum* farming management, the most effective planting model for increasing the production of seaweed *E. spinosum* and the ecological conditions of the Geger waters.

MATERIAL AND METHODS

Data were collected for 40 days from January 14 to Ferbruary 23, 2016 in the waters of Geger Beach, the site of seaweed culture development in Bali. The Probability Sampling (Random Sample) by Simple Random sampling technique was used in this study. The combination model of seaweed cultivations *E. spinosum* with *H. durvillaei* were teseted. There were three types of premises planting models and one control as follows:

1. *E. spinosum* planted separately used as control
2. *E. spinosum* planted alternately with *H. durvillaei* in 1 ropeline
3. *E. spinosum* planted alternately with *H. durvillaei* in 1 plot
4. *E. spinosum* planted with fenced *H. durvillaei*

Data is collected every 10 days by removing the seaweed on a ropeline that have been marked using numbers. The measured parameters include absolute growth, daily growth, standards geowth rate, average daily growth and water quality parameters. The formulas for each growth parameters describes as follows:

a. Absolute growth (Effendi, 2003)

$G = Wt - Wo$..(1)

G : Absolute growth
Wt : Weight at the time of observation (g)
Wo : Initial Weight (g)

b. Daily growth (Effendi, 2003)

$Gr = Wt - Wo/t$..(2)

Gr : Daily Growth Rate
Wt : weight at the time of observation (g)
Wo : Initial Weight (g)
t : time (days)

c. Specific Growth Rate (Effendie,1997)

$$SGR = \frac{\ln wt - \ln wo}{t} x100\% \ldots\ldots\ldots\ldots(3)$$

SGR : Standard Growth Rate (%)
ln*wt* : Seaweed Final Weight *(g)*
ln*wo* : Seaweed Start Weight (g)
t : Time (days)

d. Average Daily Growth (Effendi, 2003),

$$ADG = \sqrt[t]{\left(\frac{wt}{wo} - 1\right)} x100\% \ldots\ldots\ldots\ldots(4)$$

ADG : Average Daily Growth (%)
Wt : Weight after t days *(g)*
Wo : Initial Weight *(g)*
t : Time (days)

The data were analyzed by analysis of variance ANOVA (One Way ANOVA) followed by Tukey's test at level probability of 5%. All statistical tests was conducted by using SPSS 2.0.

RESULTS AND DISCUSSION

The results of data analysis showed that the growth of seaweed *E. spinosum was* significantly different in each planting models at the age of 20 days, 30 days and 40 days. The average wet weight *E. spinosum* has increased in each model of planting (Table 1). This might because the seeds used was good and having only few pest problems. Soenardjo (2011), stated that the better seeds selection resulted in the success of a cultivar. In addition, the results showed that the water quality parameters was good and appropriate to support the growth of seaweed (Table 2). The current velocity was enough for well diffusion of nutrients. The stable water salinity resulted in the constant seaweed growth and the brightness was also good where the light able to penetrate optimally and has a positive impact on the photosynthesis process.

Table 1. Average Growth Weight *E. spinosum*

Observation	Cultivation Model			
	Control	Alternately 1 ropeline	Alternately in 1 plot	Fenced *H. durvillaei*
Initial Weight (g)	100.0 ± 0.0 [a]	100.0 ± 0.0 [a]	100.0 ± 0.0 [a]	100.0 ± 0.0 [a]
10 days age (g)	167.3 ± 4.0 [b]	171.0 ± 2.5 [b]	159.3 ± 4.0 [b]	179.3 ± 11.6 [b]
20 days age (g)	238.0 ± 8.6 [d]	227.0 ± 12.4 [d]	202.7 ± 7.0 [c]	253.3 ± 16.5 [d]
30 days age (g)	289.0 ± 7.9 [e]	288.0 ± 12.7 [e]	282.3 ± 13.9 [f]	349.0 ± 22.7 [g]
40 days age (g)	395.3 ± 13.9 [h]	396.7 ± 13.8 [h]	379.3 ± 12.5 [h]	456.0 ± 23.4 [i]

Diferent superscript letters in in the same line are significantly different ($p<0.05$)

Tabel 2. Water Quality Parameters

No	Parameters	Measurement result
1	Temperature (^{0}C)	28.1 – 30.1
2	Salinity (ppt)	30 – 32
3	Disolve oxygen (ppm)	4 – 5.1
4	pH	8 – 8.4
5	Current velocity (m/s)	0.1 – 0.2
6	Visibilty (%)	100

According to previous studies, the ideal range of water quality parameters for seaweed growth namely the temperature of 27-30°C (Sulistijo, 1996), 28-35 ppt of salinity (Ditjenkanbud, 2005), dissolved oxygen > 4 ppm (Sulistijo *et al*., 1996), pH 7-9 (Bambang, 2006) and current velocity of 1.1 to 0.3 m/sec (Ambas, 2006). The similar result of the seaweed growth were also obtained in the studies conducted by Wiyanto (2014), but in contrast to the results of research conducted by Apriyana (2006), which obtained the growth of *E. spinosum* growth ranging from age 10 to 30 days day and decreased at 40 days.The decline at the age of 40 days might be due to the saturation of cell division. Seaweed has a rapid growth during adaptation process and then going slowly since the decline in the cells ability.

The best results of the wet weight was obtained from the final production and 10 weights per day i.e. on planting models *E. spinosum* fenced by *H. durvillaei*. This might because *H. durvillaei* protect *E. spinosum* from the pests and diseases when located at the center that allow inhibition of the weeds growth. According Arthana et. al (2015) *H. durvillaei* has advantage of resistance to pests, diseases and undesirable fish. In addition, the location of *E. spinosum* which is fenced *H. durvillaei* has basic coarse sandy substrate with a brightness of 100%, so that the movement of current and light penetration can occurs optimally. Sahoo and Yarish (2005), suggested that the area which has a sand rough up the rock is a great place to cultivate Eucheuma sp. Where as the light penetration utilized as energy source photosynthesis process, resulted in increasing of the seaweed growth (Susanto, 2005). While the lowest production was obtained on the model of planting alternating one plot that allegedly because the substrate planting sites located in the area of sea grass. It is probable there will be competition for the absorption of nutrients, catching of the light intensity for photosynthesis process, and space competition that can affect growth. Soenardjo (2011), suggested that the more population in the same location creates the higher level of competition.

Generally, the highest absolute growth and daily growth of seaweed in each model were obtained from the planting at 40 days. The highest result was shown by the model of planting alternating one ropeline, while the lowest growth occurred in the planting models alternately in one plot. This was apparently due to the model of planting alternating one ropeline growth was constant and substrate conditions are ideal for the growth in the form of coarse sand, whereas the substrate on the model of planting alternating one plot were influenced by seagrass which caused the competition to obtain radiation of sunlight and nutrient content. Sulistyawati (2003), said that the differences in both qualitative and quantitative irradiation received by *thallus* is a major factor in the photosynthesis rate that will support the growth of algae. On the other hand, Sunarjo *et al*., (2000), stated that nutrient is a limiting factor which can increase or inhibit the growth of seaweed. Similar results obtained by Wiyanto (2014), where the in absolute growth and daily growth of seaweed *E. spinosum* reared for 40 days 32,48 g and 3,25g, respectively. In this study, the better results were obtained in the amount 108,67 g and 10.87, respectively.

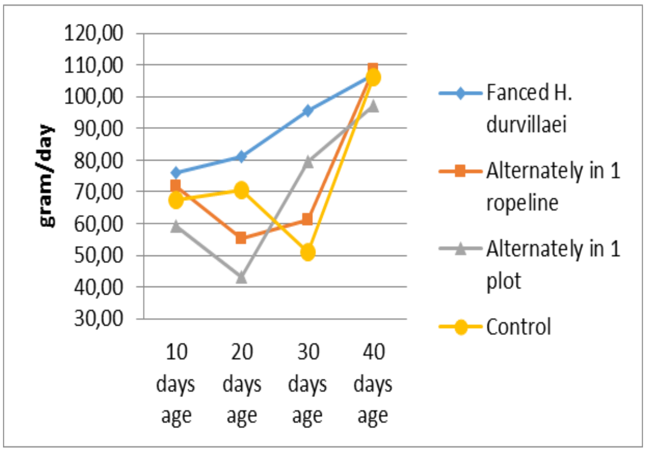

Figure 1. Weight Absolute *E. spinosum*

While the standard growth and the average highest daily growth generally occurs at the age of 10 days and decline rapidly with wet weight and length of maintenance. This might be related to the process of cell growth and development of seaweed. According to Nursyahran and Reskiati (2013), the phase of the growth rate of plants include seaweed in the youth age will perform cell enlargement, division and elongation as well as the formation of buds, so the percentage of standard growth rate is increased. After seaweed reaching adult stage, the auxin will encourage the formation of ethylene in the plant cells which inhibits ethylene vegetative growth, but allows the generative growth.

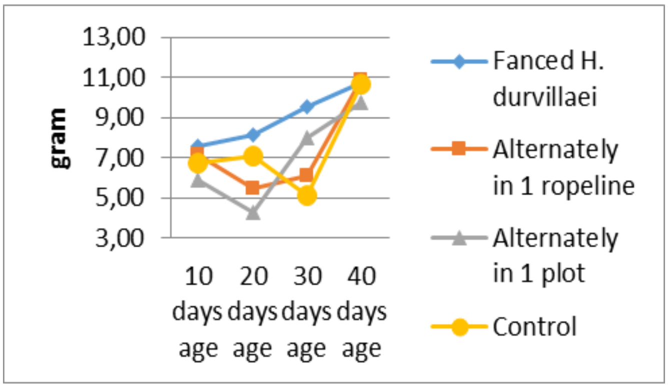

Figure 2. Daily Growth

Standard growth and average daily growth was highest in *E. spinosum* planting models are lined with *H. durvillaei*. This probably due to *E. spinosum* position in the midst *H. durvillaei* that protect it from pests and disease that mignt be inhibit the seaweed growth. In addition, *E. spinosum* is adapt quicker than the kelp on the other planting models.

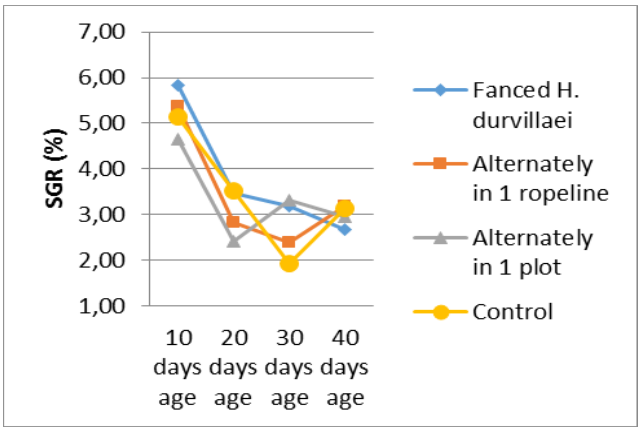

Figure 3. Standard Growth Rate

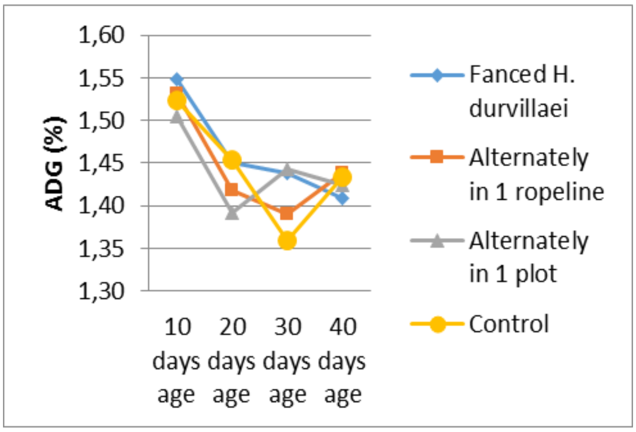

Figure 4. Average Daily Growth

Standard growth results in this study are smaller than the results obtained by the SMK 1 Karimunjawa which is 6.4%, but higher than the results obtained Susanto (2005) and Wiyanto (2014), which is a standard growth of 2,97% and 2.87%, respectively. In general, the results obtained in both categories are in appropriate with the results from Runtuboy (2004); Supratno (2007) in Syahlun (2013) who stated that seaweed farming activities considered good if the development of specific growth of at least 3%.

Based on the growth in length, on each model of cultivation also showed different results. All models cultivation has increased every 10 day with similar increase in weight (Table 3).

This is in contrast to the results of research conducted by Apriyana (2006), who is stated that the increasing length growth occurs in 10 until 30 days of age, and decreased at 40 days. Based on the production results, cultivation model of alternating one ropeline is better than the other models, where the weight growth is more inclined to the long growth. The other models were tend to has more weight growth.

This is in accordance with Rahman (2004), who stated that the pattern of the seaweed growth at the beginning of the planting are more concentrated on weight gain (gravimetric) compared to the increase of volume (volumetric). Based on the results of the research conducted by Apriyana (2006), *E. spinosum* which is on the surface of the water has 28.27 cm in length, while at the bottom, it reaches 39,64 cm in lenght. Based on the absolute growth, daily growth, the standard growth and the average percentage of daily growth, the highest growth in length was obtained at 10 days and then tends to decrease.

The highest results in both of absolute growth and daily growth were obtained on the model of planting alternating one ropeline, while the highest of standard average daily growth were obtained from the model of *E. spinosum* which was lined with planting *H. durvillaei*, This indicates that the length growth will further increase with the weight at a certain time (Nursyahran and Reskiati, 2013).

Table 3. Average Growth Lenght *E. spinosum*

Observation	Cultivation Model			
	Control	Alternately 1 ropeline	Alternately in 1 plot	Fenced *H. durvillaei*
Initial lenght	15,8 ± 1,0	14,0 ± 0,8	13,8 ± 1,0	12,3 ± 1,5
10 days age (cm)	21,7 ± 3,5	20,0 ± 3,0	18,3 ± 1,5	17,3 ± 0,6
20 days age (cm)	24,0 ± 3,0	20,7 ± 3,1	25,3 ± 2,5	27,0 ± 2,7
30 days age (cm)	25,7 ± 2,5	25,3 ± 2,5	23,3 ± 0,6	23,3 ± 1,5
40 days age (cm)	26,7 ± 3,5	27,0 ± 2,7	26,4 ± 1,5	26,0 ± 1,0

CONCLUSIONS

1. *H. durvillaei* have a considerable role to be effective in improving the production *E. spinosum* for 40 days which amount up to 60.7% compared to controls.
2. The most effective planting models in increasing the production of seaweed *E. spinosum* is fenced by *H. durvillaei* planting models.
3. The ecological conditions of Geger Beach waters are still conducive to seaweed cultivation, which has 27.7-30.1°C temperature, salinity ranged of 30 to 32.3 ppt, DO 4 to 5.1 ppm, pH 8 to 8.4, the current velocity 0.7-0.2 m/s and brightness 100%.

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