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Application of Seaweed *Gracilaria verrucosa* Tissue Culture using Different Doses of Vermicompost Fertilizer

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ABSTRACT

Market demand on the need of agar in Indonesia continues to increase from year to year, so it takes seaweed cultivation technology to improve the quantity and quality of seaweed especially for *Gracilaria verrucosa*. The purpose of this research is to analyze the doses of vermicompost fertilizer for the quality of agar (viscosity, gel strength) and nutrient content (carbon, nitrogen and phosphorus) of *G. verrucosa* seaweed from tissue culture. This research was conducted in seaweed pond of Pangkah Kulon Village, Ujung Pangkah District, Gresik Regency, East Java, from April to July 2017. The experimental design used in this study was completely randomized design (CRD) with 6 treatments and repeated 3 times. The experimental treatment was a different dose of vermicompost fertilizer, consisting of 0 ppm (Treatment A), 400 ppm (Treatment B), 425 ppm (Treatment C), 450 ppm (Treatment D), 475 ppm (Treatment E) and a dose of 500 ppm (Treatment F). The results showed that the quality of agar viscosity (cps) was best in the treatment of 450 ppm dosage for 67 cps. The quality of agar gel strength (g/cm^2) was best at treatment of 400 ppm dosage with a value of 77.2 g/cm^2. While the nutrient content of seaweed *G. verrucosa* form of carbon (%) was best in treatment of 450 ppm dosage with a value of 25.74%, the content of nitrogen and phosphorus (%) was best at treatment of 400 ppm dosage with values of 2.02% and 0.26% respectively.

INTRODUCTION

Gracilaria verrucosa is a species of seaweed of the class Rhodophyceae which is included in a producer group of gelatin. The main function of gelatin is as a stabilizing in- gredient, stabilizers, emulsifiers, fillers, purification, gel- makers and others. Some industries which utilize the gel- forming property are food, pharmaceutical, cosmetics, skin, photography and microbial growth industries. *G. verrucosa* seaweed is one of the marine biological resources which has an important economic value. The development of *G. verrucosa* cultivation in Indonesia will provide great ben- efits as the demand on agar is increasing (Imaniar et al. 2013).

East Java itself is one of the top 10 largest seaweed pro- ducer regions in Indonesia. With the potential of marine water which is very suitable for the development of sea- weed cultivation, it is not surprising that East Java trans- formed into one of the national seaweed production barn. Seaweed area in East Java reached more than 166 thousands ha from 158 thousands ha. High export market demand on seaweed also spur the business in seaweed production center, and the seaweed cultivation spread in a number of areas (BPS East Java Province 2013).

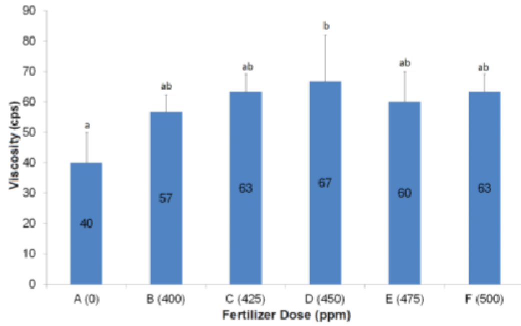
Market demand on agar in Indonesia continues to in- crease from year to year, so it takes the marine seaweed cultivation technology in terms of improving the quantityand quality. According to Arhan (2008), during 2004-2008, the price of dry *Gracilaria* seaweed per kg decreased from Rp. 5,000-15,000 with seaweed production ranging from 27,874-69,264 tons and agar production from 5,574-7,696 tons. Indonesia has not sufficiently high demand for *Gracilaria* seaweed during 2004 to 2008 as the raw mate- rial for producing agar (Febriko et al. 2008).

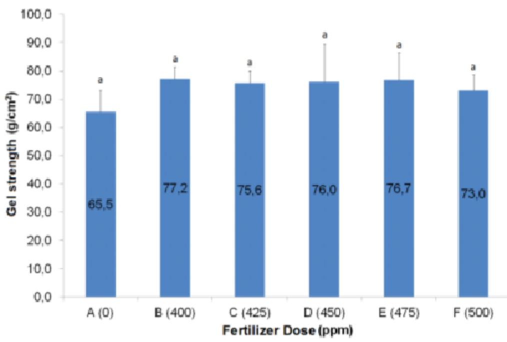
According to Mukhtar (2008), in 2007 Indonesia sea- weed production reached 94 thousand tons. At the end of 2008, the supply of seaweed to market demand was reduced by 13.1%. This is because the productivity of seaweed cul- tivation farms decreased due to poor management of ponds, environmental pollution and environmental destruction. This causes a decrease in the quality and quantity of *G. verrucosa* seaweed. One of the success factors for increase in quality and quantity is the input of superior cultivation technology by way of tissue culture. Purification of sea- weed seedlings has a goal to get the seeds free from disease or pure seeds. Then the seeds are given nutrients from ferti- lizers, which can repair and reproduce new cells in the thal- lus seaweed, so the quantity and quality of seaweed are growing (Mustafa et al. 2008).

RESULTS AND DISCUSSION

Quality of Agar Seaweed *Gracilaria verrucosa*

Viscosity (cps): The values obtained from the response variables studied in each experimental running are shown in Fig.2. During maintenance, seaweed growth obtained the best growth for horizontal Length in treatment B with a value (0.87). Likewise, the growth in vertical Length of seaweed in treatment B obtained the best growth. These results illustrate growth and decline in Seaweed (*Gracilaria verrucosa*) and increased stocking density. The methods in cultivation activities can affect the rate of growth, utilizing sunlight in the process of photosynthesis. The increase in seaweed growth can be seen from the increase in spores, thallus, and Length and weight. Based on the calculation of Analysis of Variance (ANOVA), it shows that the growth rate of *Gracilaria verrucosa* Seaweed with different density treatments showed no significant effect ($p>0.05$), namely $0.446>0.05$. The further test was not carried out using the Tukey Test because the results Analysis of Variance (ANOVA) showed that were not significantly different in all stocking density treatments on the growth of *Gracilaria verrucosa* seaweed.





Gel strength (g/cm^2): From the data results on the growth of Seaweed (*Gracilaria verrucosa*) in the tarpaulin pool, the growth results were low. This is presumably due to the environmental conditions of *Gracilaria sp.* which is not right, causing growth that is not optimal. This is caused by climatic factors because, during maintenance in certain weeks, there is rain, which results in the seaweed getting less sunlight. Seaweed needs sunlight to do photosynthesis.

In the depths of water, the sun's light intensity is very low. Seaweed cannot live because it cannot carry out photosynthesis. The amount of sunlight that enters the waters is closely related to water transparency. Things that significantly affect the rate of increase in Length and weight of seaweed are the differences in the use of sunlight used in the photosynthesis process. Sedimentation in seaweed cultivation waters dramatically affects the growth process in the diffusion of nutrients and absorption of sunlight in the photosynthetic process. The brightness level of sunlight that enters the water bodies, the sediment attached to the thallus of seaweed will affect the photosynthesis process. Several factors that influence the growth rate of seaweed are the depth of culture water, nutrient supply, and the amount of sunlight entering water bodies Subaryono & Mardinah (2011),.

Nutrient Content of SeaWeed *G. verrucosa*

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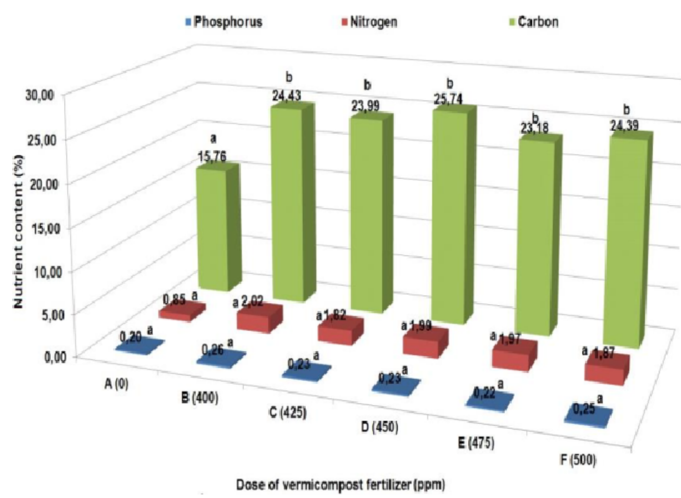
The content of carbon, nitrogen and phosphorus: The results of water quality in each experimental running are shown in Table 1. The temperature ranged from 29.2 - 32.8^{O}C. According to, the temperature is between 27-33^{o}C. This value is in a suitable range for the life and growth of cultivated organisms, including seaweed. The good temperature for increasing the quality and quantity of seaweed is in the range of 20 - 28°C., 25-26oC. Gracilaria seaweed can live in high temperature ranges, namely 0-35^{o}C. Temperature with a good range greatly affects the increase in Length, weight, and quality in utilizing nutrients and sunlight for the photosynthesis process. The temperature that is too high will slow down the metabolic process to produce good seaweed growth. The high temperature in the waters can be anticipated by seaweed through the current speed.

pH range of 6.54 - 8 is a value that is suitable for the growth of a commodity that will be cultivated, including milkfish, Vannamei shrimp, and seaweed. In the study using the polyculture culture of milkfish, Vannamei shrimp, and seaweed, the pH range was 7.5-9. According to, pH 7.50 to 7.87.The pH at night will be high and decrease in the morning, but milkfish, shrimp, and seaweed can still tolerate this. The optimum pH value of seaweed growth is around 7.5 – 8.0. The pH concentration value results from the by-product of photosynthetic activity by phytoplankton and the respiration of aquatic organisms associated with it that contribute H^+ ions and OH^- ions so that varying pH values are obtained.

Dissolved Oxygen (DO) concentration range is 1.1 - 3.4 mg/L. This condition is a low value for the DO quality of polyculture cultivation, but it can still be tolerated by the commodities of milkfish, Vannamei shrimp, and seaweed. This is strengthened by research [17] in his research with the polyculture cultivation of milkfish, Vannamei shrimp, and seaweed commodities to obtain a Dissolved Oxygen range of 0.96-9.34 mg/L, but it can still grow. Obtained dissolved oxygen content in the range of 4.1-5.6 mg/L, which means that it is above the permissible water quality criteria of > 3 mg/L.

Salinity, range between 1 - 3 ppt. The right salinity to produce seaweed growth is 32 ppt. *Gracilaria* species can live in a wide salinity ranging from 10 - 40 ppt. At 25 ppt salinity, seaweed can grow well in producing the best agar quality. *Gracilaria* is a type of seaweed that can live in a very wide salinity (euryhaline). Salinity fluctuations in cultivated waters significantly affect metabolic processes in producing the growth and quality of *Gracilaria* seaweed. *Gracilaria sp.* could surviving conditions of relatively high salinity fluctuations, The optimum salinity criteria, the right salinity for the maintenance of *Gracilaria sp.* in the pond, are about 15-25 ppt. The low salinity is thought to be due to the high rainfall at the time of measurement. Mixing rainwater that enters the ponds can cause salinity dynamics, where traffic levels can be low. Salinity can directly affect seaweed production, where salinity dramatically affects the growth of seaweed. The salinity cannot be too low or too high. If the salinity is low, far below the tolerance limit, the seaweed will be pale, break easily, and become soft, eventually rot and do not grow naturally and die immediately available for plant use.



Redox (Eh) describes the reduction and oxidation processes that occur in the soil so that these redox parameters are part of the parameters to determine the quality of pond soil [35]. A high and positive Eh or pe value indicates an oxidative condition; on the other hand, a low or even negative Eh or pe value indicates a reductive condition. The average redox potential of the polyculture pond soil for Vannamei shrimp, milkfish, and seaweed on day 0 was (-281 mV - 352 mV), and the soil attenuation value at the end of the study ranged from (-42mV to -279mV). The average negative value of pond soil redox potential indicates that the soil is in a reduced condition, producing compounds that are toxic to aquatic organisms such as H_2S, NO_2, and NH_3 compounds. This is because the pond is completely filled with water. After all, it is used for the polyculture of Vannamei shrimp, seaweed, and milkfish, resulting in a reduction condition in the pond's bottom soil. The negative soil redox potential also indicates the accumulation of organic matter under anaerobic conditions [36]. At the end of the study, there was a decrease in the potential redox value of the soil; this is thought to be due to seaweed, which can improve the reduction rate in the soil. Following the opinion of [35][34][37], *Gracilaria* can absorb Nitrogen (N) and phosphorus (P). One source states that the ability of *Gracilaria* to absorb Nitrogen in water contaminated with organic matter reaches a concentration of 0.4 grams N/m^2/day; the seaweed quickly reduces the nutrient content in aquaculture pond wastewater. (Choirina et al. 2013).

CONCLUSION

The conclusion from this study is:

1. The best quality of agar viscosity (cps) was in the treat- ment of 450 ppm fertilizer dose with 67 cps.
2. The best quality of agar gel strength (g/cm^2) was in the treatment of 400 ppm fertilizer dose with 77.2 g/cm^2.
3. The best nutrient content of *G. verrucosa* in this study was carbon 25.74% with dose of 450 ppm, nitrogen 2.02% and phosphorus 0.26%, both with dose of 400 ppm.

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