REPUBLIK INDONESIA
KEMENTERIAN HUKUM DAN HAK ASASI MANUSIA

SURAT PENCATATAN CIPTAAN

Dalam rangka pelindungan ciptaan di bidang ilmu pengetahuan, seni dan sastra berdasarkan Undang-Undang Nomor 28 Tahun 2014 tentang Hak Cipta, dengan ini menerangkan:

Nomor dan tanggal permohonan	:	EC00201948007, 29 Juli 2019
Pencipta		
Nama	:	**Dr. Andi Rahmad Rahim, S.Pi, M.Si.**
Alamat	:	Jl. Raya Cerme Kidul RT/RW 002/002 Desa Cerme Kidul, Kecamatan Cerme, Gresik, Jawa Timur, 61171
Kewarganegaraan	:	Indonesia
Pemegang Hak Cipta		
Nama	:	**UNIVERSITAS MUHAMMADIYAH GRESIK**
Alamat	:	Jl. Sumatera No. 101 GKB, Gresik, Jawa Timur, 61121
Kewarganegaraan	:	Indonesia
Jenis Ciptaan	:	**Karya Tulis (Artikel)**
Judul Ciptaan	:	**UTILIZATION OF ORGANIC WASTES FOR VERMICOMPOSTING USING LUMBRICUS RUBELLUS IN INCREASING QUALITY AND QUANTITY OF SEAWEED GRACILARIA VERRUCOSA**
Tanggal dan tempat diumumkan untuk pertama kali di wilayah Indonesia atau di luar wilayah Indonesia	:	29 Juli 2019, di Gresik
Jangka waktu pelindungan	:	Berlaku selama 50 (lima puluh) tahun sejak Ciptaan tersebut pertama kali dilakukan Pengumuman.
Nomor pencatatan	:	000148051

adalah benar berdasarkan keterangan yang diberikan oleh Pemohon.
Surat Pencatatan Hak Cipta atau produk Hak terkait ini sesuai dengan Pasal 72 Undang-Undang Nomor 28 Tahun 2014 tentang Hak Cipta.

a.n. MENTERI HUKUM DAN HAK ASASI MANUSIA
DIREKTUR JENDERAL KEKAYAAN INTELEKTUAL

Dr. Freddy Harris, S.H., LL.M., ACCS.
NIP. 196611181994031001

Asian Jr. of Microbiol. Biotech. Env. Sc. Vol. 20 (December Suppl., No. 2) : 2018 : S17-S23

ISSN-0972-3005

UTILIZATION OF ORGANIC WASTES FOR VERMICOMPOSTING USING *LUMBRICUS RUBELLUS* IN INCREASING QUALITY AND QUANTITY OF SEAWEED *GRACILARIA VERRUCOSA*

ANDI RAHMAD RAHIM*

Department of Aquaculture, Faculty of Agriculture, University of Muhammadiyah, Gresik, East Java, Indonesia

(Received 4 August, 2018; accepted 25 October, 2018)

Key words : *Absolute weight, Content of Carbon, G. verrucosa, Quality of Agar, Vermicompost.*

Abstract– Seaweed *Gracilaria verrucosa* is a superior commodity with high economic value, especially in East Java. However, seaweed quantity and quality decrease from year to year due to the decreasing productivity of the cultivation ponds. This decrease is caused by poor pond maintenance and inorganic fertilizer application. Abundant wastes around the ponds can be utilized as the feed for the cultivation of earthworms that will produce environmentally friendly and economical vermicompost fertilizer to increase the pond productivity. One of the parameters to increase the pond productivity is by increasing the quality and quantity of seaweed *G. verrucosa*. The purpose of this research is to analyze the utilization of pond wastes as the feed for the cultivation of earthworms in producing vermicompost fertilizer. This research was conducted in Pangkah Wetan village, Ujungpangkah Subdistrict of Gresik Regency, Laboratory of Fisheries Universitas Muhammadiyah Gresik, Laboratory of Food Quality and Laboratory of Soil Science Universitas Brawijaya Malang. This study used the completely randomized design (CRD) with 5 treatments and 3 replications. The results of the research showed that vermicompost fertilizer using banana stem waste could increase the number of cells, absolute weight and carbon content in seaweed *G.verrucosa* of 199 cells/mm^{-3}, 48.51 g and 29.47%, respectively. For the quality, the viscosity was 153.0 cps with vermicompost fertilizer using *Imperata* and the gel strength was 58.5 g/cm^2 with vermicompost fertilizer using the combination of waste. Quality of water and soil range of carbon 725.78 - 4711.46 ppm and 14558.67 - 27051.00 ppm; nitrogen 14.61 - 94.88 ppm and 1200.00 - 2266.67 ppm; phosphorus 18.76 - 37.28 ppm and 16.05 - 24.22 ppm.

INTRODUCTION

Seaweed *G. verrucosa* is one of the marine biological resources with significant economic value. The development of *G. verrucosa* cultivation in Indonesia will provide great benefits as demand for agar is increasing. East Java is one of the 10 largest seaweed producing regions in Indonesia. With the potential of very suitable marine waters for the development of seaweed cultivation, it is not surprising that East Java transforms into one of the national seaweed production areas. Seaweed areas in East Java reach more than 166 thousands Ha.

Gresik is one of the regencies in East Java located in the northern coastal area of Java Island with a coastline of ± 140 Km. Almost one-third of the Gresik Regency area is coastal areas, making it have the potential condition for fishery resources. The area of cultivation ponds in Gresik Regency is 17,835.02 Ha of brackish ponds (Maulana and Rima, 2014). This makes the abundant and potential of fishery resources through aquaculture in Gresik Regency, especially for seaweed *G. verrucosa* cultivation.

Occurring problems in Gresik Regency are the decline in pond productivity caused by the use of inorganic (artificial/chemical) fertilizers and excessive yet less optimal pond maintenance. Rahmad (2012) state that decreased productivity of Seaweed cultivation is caused by bad fish farming, environmental pollution, and destruction of pond environment. Consequently, the production of seaweed *G. verrucosa* has decreased in quality and quantity.

***Corresponding author's email**: mamat.perikanan@gmail.com

In the pond area of Gresik Regency, seaweed cultivation is done by polyculture with shrimp and milkfish. In this polyculture process, chemicals and artificial feeds are widely used in the cultivation process. Consequently, within 4-6 months of maintenance, wastes from the remaining feeds and chemical fertilizers are able to damage the soil structure and to make the ponds become acidic. The pond wastes will have adverse effects on aquatic ecosystems, in which waste disposal is about 30 percent or 4,500 kg of feed stocks distributed in one cycle for one pond or 15,000 kg as we estimate with FCR (Feed Conversion Ratio) of less than 1:18. Moreover, the resulting liquid wastes from chemical fertilizers are around 10 - 30 percent in which water discharges are done mid-cycle every day (Rudiyanti and Astri, 2009). Besides, a lot of wastes are found around the ponds such as banana stem and dry grass wastes. Organic wastes in the form of dry grass, banana stem, and pond wastes can be used as the feed for the cultivation of earthworms in producing environmentally friendly organic fertilizer.

The excessive use of inorganic fertilizers leads to increased pollution of pond waters, thus reducing the pond productivity in terms of quantity and quality of fishery products. So, it is necessary to utilize the existing wastes around the ponds as the feed for the cultivation of earthworms in producing environmentally friendly organic fertilizer as an effort to reduce the use of inorganic fertilizers. The vermicomposting concept includes some species of earthworms which feed on organic wastes then convert the wastes into a simple form in the digestive system of earthworms, resulting in the worm castings (the result of the earthworm cultivation). In the vermicomposting medium using earthworms, there are many macronutrients functioning for the fertility of pond soil and environmental pollution reduction (Morales *et al*., 2014).

Wastes around ponds such as feed/fertilizer wastes, *Imperata*, and banana stem can be utilized as the feed in the process of vermicomposting using earthworms to produce organic fertilizers that can increase the pond productivity and reduce the use of inorganic or chemical fertilizers which are relatively expensive and can decline the pond productivity in the long term. Therefore, based on the above description it is necessary to conduct research on the utilization of organic wastes in vermicomposting using earthworms to produce the best quality and quantity of seaweed *G. verrucosa*.

MATERIALS AND METHODS

Time and Place: The research was conducted in the Laboratory of Fisheries Universitas Muhammadiyah Gresik, Laboratory of Food Quality Universitas Brawijaya Malang, and Laboratory of Soil Science Universitas Brawijaya Malang from April to July 2018.

Preparation of materials: The process in conducting the research included preparation of experimental containers and preparation of cow manure, soil, *Imperata cylindrica*, Impermeable feed/fertilizer, and banana stem from the cultivation ponds. Organic matter used as the medium and the feed for earthworms were collected around the area of cultivation ponds. The experimental containers in the first stage of the research were 36 pieces of 35 x 35 x 15 cm plastic containers. All of the experimental containers were perforated with 9 holes of 3mm at the bottom and covered with plastic trim. The medium of cow manure as the starter was 10 kg and soil was 5 kg. The medium was mixed and placed at the bottom of each container. Cow manure and soil were mixed one day before earthworms were put on the medium. Other organic wastes such as *Imperata cylindrica* and banana stem were roughly chopped into 2-3 cm in thickness, put into each container, and stored for 7 days. After 7 days, the wastes were soaked for 1 day and drained. Organic wastes from the ponds were 10 kg of waste weight.

Adult earthworms were weighed 26 g/1 kg of organic matter used. Temperature and pH measurements were performed every 10 days during the study. Stirring and water spraying were conducted every 5 days on the vermicomposting medium using earthworms. The fertilizers were harvested after 60 days of observation.

After the treatment of vermicompost fertilizers completed, the fertilizers were applied on seaweed *G verrucosa* and the effect on the quantity and quality was observed. The experiment container for seaweed *G. verrucosa* was an aquarium with a height of 25 cm and a width of 55 cm filled with brackish water (pond water) to a height of 15 cm. Each treatment was given a lamp with a capacity of 40 watts and aerator for air supply in the aquatic medium. Fertilizers as the results of 60-day vermicomposting using earthworms *L. rubellus* on different organic matter were applied to each experiment container with a spread method at a dose of 450 ppm (Rahmad *et al*., 2015).

Observation parameters: The parameters observed in this laboratory-scale study were the quality measurement of the viscosity using viscometer (cps) and gel strength (g/cm^2) at the end of observation (day 42) in Laboratory of Food Quality Universitas Brawijaya Malang. Measurement of the mineral content of seaweed *G. verrucosa* in the form of carbon (%), water quality and soil quality using UV-VIS spectrophotometer was done at the end of the research (day 42) in Laboratory of Soil Science Universitas Brawijaya Malang. Cell characteristics of seaweed *G. verrucosa* in the form of cell number (mm^{-3}) were observed at the beginning (day 0) and the end (day 42) using digital ocular magnification microscope 80x in Laboratory of Fisheries Universitas Muhammadiyah Gresik. Measurement of absolute weight using the analytical scale with the level of accuracy of 0.0 g at pond of Pangkah Wetan, Gresik. Using the formula illustrated in (Equation 1).

Absolute weight (g) = Final weight – Initial weight

Equation 1. Absolute weight formula

Research Design: This research used the completely randomized design (CRD) with 5 treatments and 3 replications, resulting in 15 units of treatments:

Treatment A: Vermicompost Fertilizer (Without the addition of waste around the ponds)

- 26 g earthworms/kg of organic matter (400 g Cow Manure: 200 g Soil: 400 g Straw)

Treatment B: Vermicompost Fertilizer (With waste of feed/fertilizer)

- 26 g earthworms/kg of organic matter (300 g Cow Manure: 100 g Soil: 300 g Straw: 300 g Feed/fertilizer)

Treatment C: Vermicompost Fertilizer (With *Imperata*)

- 26 g earthworms/kg of organic matter (300 g Cow Manure: 100 g Soil: 300 g Straw: 300 g *Imperata cylindrica*)

Treatment D: Vermicompost Fertilizer (With waste of banana stem)

- 26 g earthworms/kg of organic matter (300 g Cow Manure: 100 g Soil: 300 g Straw: 300 g Banana Stem)

Treatment E: Vermicompost Fertilizer (Combination of waste around the ponds)

- 26 g of earthworms/kg of organic matter (300 g Cow Manure: 100 g Soil: 300 g Straw: 100 g Feed/Fertilizer: 100 g *Imperata cylindrica*: 100 g Banana Stem)

Statistical analysis: Data analysis on this study used ANOVA (Analysis of Variance) to examine the effect of fertilizers with different organic matter on the quantity and quality of seaweed *G. verrucosa* ($p<0.05$). If the effect was significantly different, Tukey's test was conducted to identify the difference between treatments using SPSS version 17. Water and soil quality were analysis with descriptive.

RESULTS AND DISCUSSION

Number of Seaweed *G. verrucosa* Cells (Cells/mm^{-3})

From the results of the research, the highest number of seaweed *G.verrucosa* cells was in treatment D using vermicompost fertilizer with banana stem waste of 199 cells/mm^{-3}. Analysis of variance (ANOVA) showed that different organic wastes in vermicomposting using earthworms showed a significant effect on increasing the number of seaweed *G. verrucosa* ($p<0.05$). Tukey's test further showed that treatment of banana stem waste (Treatment D) gave a significant difference to the treatment of fish feed waste (Treatment B) ($p<0.05$). Whereas, treatment without waste (Treatment A), treatment of fish feed waste (Treatment B) and treatment of waste combination (Treatment E) did not give a significant difference in each treatment ($p>0.05$) (Figure 1).

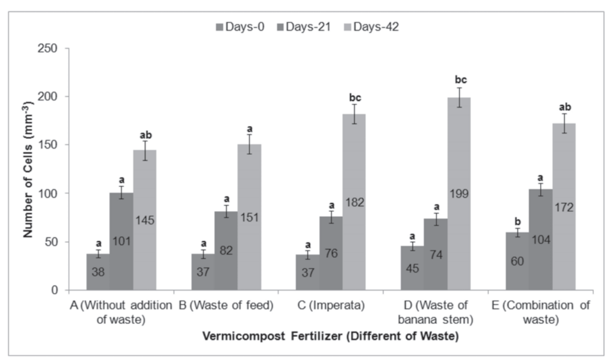

Fig. 1. The number of Seaweed *G. verrucosa* Cells (mm^{-3}).

The number of seaweed *G.verrucosa* cells at day 42 ranged from 145-199 cells/mm^{-3} (Figure 1). Rahmad (2015) stated the number of seaweed *G.verrucosa* cells using vermicompost fertilizer ranged from 60-104 mm^{-3}.

Banana stems have important compounds such as anthraquinones, saponins, and flavonoids. These compounds serve to nourish the root growth to help plants absorb nutrients (Supriyadi, 2007). Harrison and Huard (2001) stated that seaweeds require a variety of nutritional compositions to grow such as macronutrients (N, P, K), micronutrients (Fe, Zn, Cu, Mn, Mo) and vitamins. Zuyasna *et al.* (2010) and Silea and Masitha (2006) state that the availability of nutrients needed by plants should be sufficient and balanced in accordance with their needs so that plants can stimulate thallus growth and accelerate the formation of new tissues and new shoots. The availability of banana stem waste helped the nutrient absorption to optimize the seaweed growth.

Absolute Weight of Seaweed *G. verrucosa*

From the result of the research, the highest absolute weight of seaweed *G.verrucosa* was 48.51 g with waste of banana stem (Treatment D) (Figure 2). Analysis of variance (ANOVA) showed that different organic waste in vermicomposting of earthworms showed a significant effect on increasing the absolute weight of seaweed *G.verrucosa* ($p<0.05$). Tukey's test further showed that treatment of banana stem waste (Treatment D), treatment without waste (Treatment A), treatment of fish feed waste (Treatment B), treatment *Imperata cylindrica* (Treatment C) and treatment of waste combination (Treatment E) give a significant difference in each treatment (Figure 2).

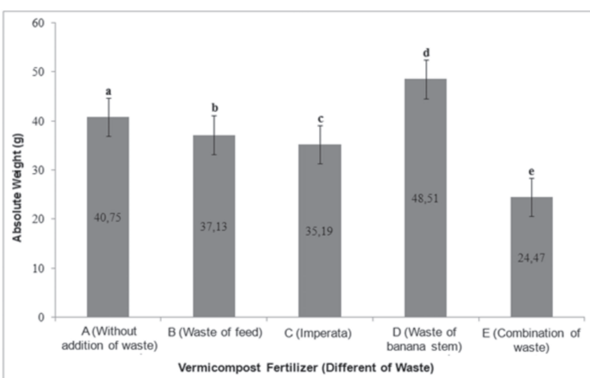

Fig. 2. Absolute Weight of Seaweed G. verrucosa (g)

The absolute weights of seaweed *G.verrucosa* ranged from 24.47 to 48.51 g. According to Rahmad (2015) for the highest absolute weights of seaweed *G. verrucosa* using vermicompos fertilizer ranged from 4.1-15.7 g. The addition of vermicompos fertilizer with banana stem waste can increase the absolute weight of seaweed *G.verucossa*. Balmori *et al.* (2013) states that, vermicompost fertilizer contains many micro and macro elements necessary in the preparation of carbohydrates, proteins, nucleic and other organic compounds that can increase seaweed growth, accelerate cell division and the formation of photosynthesis pigments. The banana stems waste capable of supplying nutrients. Wang *et al.* (2014) that, the input of organic matter contributes nutrient to the plant, the higher the nutrient content of the vermicompost fertilizer will increase of plant cells directly related to the growth and quality of the plant.

Quality of Agar

1. Viscosity of Seaweed *G. verrucosa* (cps)

From the research results, the highest viscosity was obtained in treatment C using vermicompost fertilizer with *Imperata* of 153.0 cps. Analysis of variance (ANOVA) showed that different organic wastes in vermicomposting using earthworms showed a significant effect on quality improvement for seaweed *G. verrucosa* viscosity ($p<0.05$). Tukey's test further showed that treatment with *Imperata* (Treatment C) gave a significant difference to the treatment of banana stem waste (Treatment D) ($p<0.05$). Whereas, treatment without waste (Treatment A), treatment of fish feed waste (Treatment B), and treatment of waste combination (Treatment E) did not give a significant difference in each treatment ($p>0.05$) (Figure 2).

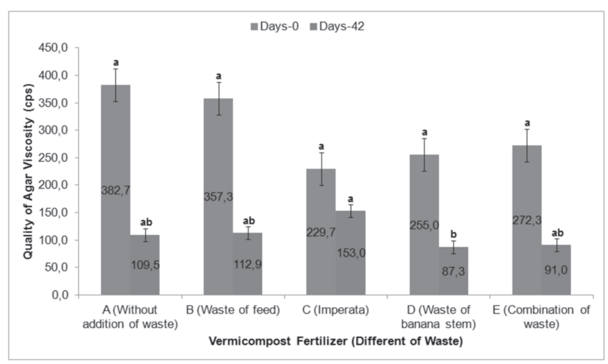

Fig. 2. Viscosity of Seaweed *G. verrucosa* (cps)

The seawater *G.verrucosa* viscosity at day 42 ranged from 87.3 – 153.0 cps (Figure 2). According to Luthfy (1998), seaweed viscosity ranged from 5 to 800 cps. One factor affecting the viscosity is the seaweed morphology because each seaweed has different thallus shape. The short thallus produces a low viscosity, while the long thallus produces a high viscosity (Wenno *et al.*, 2012). The use of vermicompost fertilizer could stimulate the growth of seaweed thallus thus increase the viscosity of seaweed *G.verrucosa*. Vermicompost fertilizers contained plant growth regulators such as auxin, gibberellins, and cytokinins which accelerated the process of cell division and formation of new shoots, resulting in the best quality and growth (Morales et al., 2014).

Gel Strength of Seaweed *G. verrucosa* (g/cm^2)

From the research results, the highest gel strength was obtained in the treatment E (Waste Combination) of 58.5 g/cm^2. Analysis of variance (ANOVA) showed that different organic wastes in vermicomposting medium showed a significant effect on quality improvement for seaweed *G. verrucosa* gel strength ($p<0.05$). Tukey's test further showed that the treatment of waste combination (Treatment E) gave a significant difference to the treatment without waste (Treatment A), treatment of fish feed waste (Treatment B), treatment with *Imperata* (Treatment C), and treatment of banana stem waste (Treatment D) ($p <0.05$). In addition, treatment without waste (Treatment A) did not give a significant difference to the treatment of banana stem waste (Treatment D) ($p>0.05$) (Figure 3).

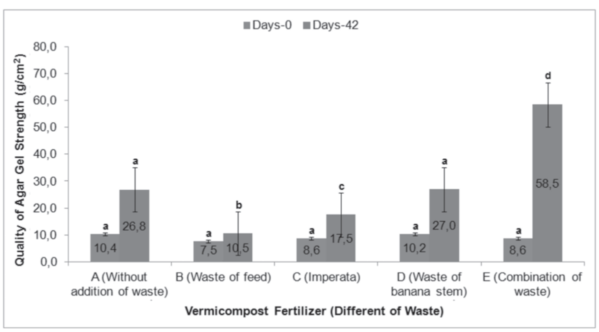

Fig. 3. Gel Strength of Seaweed *G. verrucosa* (g/cm^2)

The average seaweed *G.verrucosa* gel strength at day 42 ranged from 10.5 - 58.5 g/cm^2 (Figure 3). According to Mudjarrab (2000), the highest gel strength on the *G. verrucosa* species ranged from 20-211.8 g/cm^2. The higher viscosity was followed by increasing agar yield and decreasing seaweed gel strength (Anggadiredja *et al.*, 2008).

Carbon Content of Seaweed *G. verrucosa* (%)

From the research results, the largest carbon content was obtained in the treatment D using banana stem waste of 29.47%. Analysis of variance (ANOVA) showed that different organic waste in the vermicomposting medium using earthworms showed a significant effect on increasing the carbon content of seaweed *G. verrucosa* ($p<0.05$). Tukey's test further showed that treatment of banana stem waste (Treatment D) gave the significant difference to treatment with *Imperata* (Treatment C) ($p<0.05$). Whereas, treatment without waste (Treatment A), treatment of fish feed waste (Treatment B), treatment with *Imperata* (Treatment C) and treatment of waste combination (Treatment E) did not give a significant difference in each treatment ($p>0.05$) (Figure 4).

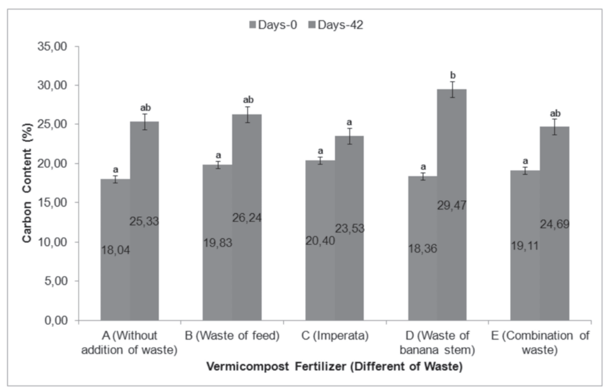

Fig. 4. Carbon Content of Seaweed *G. verrucosa* (%)

The carbon content at day 42 in this study ranged from 23.53 - 29.47%. Hambali et al (2004) stated that the carbon content of seaweed *G. verrucosa* cultivated in ponds ranged from 15.34 - 39.84%. Carbon nutrient is the main nutrient needed by seaweeds in the photosynthesis process to produce carbohydrates which are the main components of seaweeds.

Table 1. Average water quality of carbon, nitrogen and phosphorus (ppm)

Treatment	Carbon (ppm)		Nitrogen (ppm)		Phosphorus (ppm)	
	Day-0	Day-42	Day-0	Day-42	Day-0	Day-42
A (Without addition of waste)	4649.83	828.48	97.80	14.98	32.12	18. 76
B (Waste of feed)	4607.20	755.20	94.88	14.61	29.27	19.86
C (Imperata)	4711.46	768.52	96.95	16.49	28.89	19.09
D (Waste of banana stem)	4195.58	747.19	97.14	17.06	30.83	18.98
E (Combination of waste)	4185.55	725.78	92.15	18.66	37.28	18.79

Table 2. Average soil quality of carbon, nitrogen and phosphorus (ppm)

Treatment	Carbon (ppm)		Nitrogen (ppm)		Phosphorus (ppm)	
	Day-0	Day-42	Day-0	Day-42	Day-0	Day-42
A (Whithout addition of waste)	14558.67	24277.00	1466.67	2033.33	16,89	22.02
B (Waste of Feed)	16108.33	25830.33	1200.00	2000.00	18,05	23.45
C (Imperata)	16047.00	25917.00	1566.67	2033.33	16,05	22.90
D (Waste of banana stem)	18204.00	25102.33	1300.00	1866.67	15,89	24.22
E (Combination of waste)	16038.67	27051.00	1333.33	2266.67	17,70	23.28

Quality Water of Carbon, Nitrogen and Phosphorus (ppm)

The average seaweed *G.verrucosa* quality water of carbon ranged from 725.78 - 4711.46 ppm, nitrogen 14.61 - 94.88 ppm and phosphorus 18.76 - 37.28 ppm (Table 1).

Rahmad (2015) stated that the quality water of carbon ranged from 734,51 - 4754,12 ppm, nitrogen 14,91 - 98,91 ppm and phosphorus 19,84 - 38,39 ppm. There was an increase in carbon, nitrogen and phosphorus concentrations during the study. This is due to the addition of C: N: P ratio in vermicompost fertilizer which causes the increase of carbon, nitrogen and phosphorus in the waters (Komarawidjaja, 2003).

The relatively high and low concentrations of nitrogen in the waters will affect the process of protein formation in the seaweed thallus which will affect the quality of agar (Granbom *et al.,* 2004). The phosphorus element is the macro element required by the plant, but the plant uses only a small amount of phosphorus as a protein constituent component, the phosphorus deficiency will affect the process of cell division (Choirina *et al*., 2013).

Quality Soil of Carbon, Nitrogen and Phosphorus (ppm)

The average seaweed *G.verrucosa* quality soil of carbon ranged from 14558.67 - 27051.00 ppm, nitrogen 1200.00 - 2266.67 ppm and phosphorus 16.05 - 24.22 ppm (Table 2).

Siringoringo (2013) states that, the carbon content of Pond ranged from 3600 - 20360 ppm. Nirmala (2005) states, the soil nitrogen of pond ranged from 300 -2200 ppm. Rahmad (2015) states, the soil phosphorus content ranged from 18.63 - 22.22 ppm. According to Edward and Tarigan (2003) states that, phosphorus levels in marine waters ranged from 1.076 - 2.198 ppm. The longer the phosphorus and the soil touch, the more phosphorus will be fixed into the soil (Cendrasari, 2008).

CONCLUSION

The conclusions of this study are:

1. The use of vermicompost fertilizer using banana waste could increase the number of cells, absolute weights and carbon content in seaweed *G.verrucosa* of 199 cells/mm^{-3} , 48.51 g and 29.47%, respectively.
2. The viscosity quality of 153.0 cps with vermicompost fertilizer using *Imperata* was inversely proportional to the gel strength quality of 58.5 g/cm^2 with vermicompost fertilizer using the combination of waste.
3. Quality water of carbon ranged from 725.78 - 4711.46 ppm, nitrogen 14.61 - 94.88 ppm and phosphorus 18.76 - 37.28 ppm. Quality soil of carbon ranged from 14558.67 - 27051.00 ppm, nitrogen 1200.00 - 2266.67 ppm and phosphorus 16.05 - 24.22 ppm.

REFERENCES

Anggadiredja, J., Zatnika, A., Purwoto, H. and Istini, S. 2006, 2008. *Seaweed.* The Swadaya spreader. Jakarta. 147 p.

Cendrasari, E. 2008. Effectiveness of Alelopathic Components Barriers of Tithonia Diversifolia Litter, Tephrosia Candida, And Kaempferia Galanga Against Nitrification Bacterial Activity In Alfisols, Jumantono. UNS. Surakarta.

Choirina, Y., Sudadi and Widjanto, H. 2013. Effect of natural macro fertilizer on phosphorus uptake and peanut growth, on soil Alfisol, Entisol, and Vertisol. Agrotechnology Study Program. Faculty of Agriculture. Sebelas Maret University. Surakarta.

Edward and Tarigan, M.S. 2003. The Effect of Season on Fluctuations of Phosphate and Nitrate Levels in the Banda Sea. Marine Dynamics Center, Oceanographic Research Center, Indonesian Institute of Sciences, Makara. *Science*. 7 (2) : 82-89.

Granbom, M.F., Chow, P.F., Lopes, M.C., Oliveira, P., Colepicolo, E. J., Depaula and Pedersen, M. 2004. Characterization of Nitrat Reductase in the Marine Macroalga *Kappaphycus alvarezii*. *Aquatic Botany.* 78 : 295-305.

Hambali, E., Suryani, A. and Wadli, 2004. Making Various Processed Seaweed. Jakarta: Spreading Self-Helpers.

Harrison, P.J. and Hurd, C.L. 2001. Nutrient Physiology of Seaweeds: Application of Concepts to Aquaculture. *Cah. Biol. Mar.* 42 : 71-82.

Komarawidjaja, W. 2003. Seaweed *Gracilaria* sp. as Fitoremedian Organic Water Pond Culture Materials. *Journal of Environmental Technology. P3TL-BPPT*. 6 (2): 410-415.

Luthfy, S. 1998. Studied the extraction of carrageenan by a semi-refined method from *Eucheuma cottonii*. Faculty of Agricultural Technology. IPB. Bogor.

Maulana, R.H. and Rima, D.S. 2014. Formulating Criteria for Land Control in Manyar Sub-District, Gresik Regency. Department of Regional and City Planning, Faculty of Civil Engineering and Planning, Sepuluh Nopember Institute of Technology (ITS). *Journal of Engineering Permits.* 3 (2) : 2337-3539.

Morales, M.R., Sanchez, A.G. and Rodrigo, P.S. 2014. Evaluation of Green / Pruning Wastes Compost and Vermicompost, Slumgum Compost, and their Mixes as Growing Media for Horticultural Production. Facultad de Ciencias Agrarias Ambientales, Universidad de Salamanca, Avda. Filiberto Villalobos, Spain. *Scientia Horticulturae.* 172 : 155-160.

Mudjarrab, S.A. 2000. Gel Containment and Gel Strength from Several Red Algae Species In Tongkaina Coast of North Sulawesi. Department of Fishery Resources Management. Faculty of Fisheries and Marine Science. Sam Ratulangi University. Manado.

Nirmala, K., Yuniar, E. and Budiardi, T. 2005. Productivity and Parameter of Basic Chemical of Shrimp Pond Culture Windu Penaeus monodon Fab. Aged 1 and 3 Years. Department of Aquaculture and Marine Sciences, Bogor Agricultural University. *Indonesian Aquaculture Journal.* 4 (1) : 5 - 11.

Rahmad, A.R. 2012. Growth and Grass Seaweed *Gracilaria verrucosa* is nurtured with Vermicompost. The thesis of the Graduate Program of Hasanuddin University. Makassar.

Rahmad, A. R., Endang, Y.H., Happy, N., Anik, M.H. 2015. Cells Characteristics, Growth, and Quality of *Gracilaria verrucosa* Seaweed Production with Different Doses of Vermicompost Fertilizer. *International Journal of Science Technology & Engineering*. 2 (2) : ISSN (online): 2349-784X

Rudiyanti, S., Astri, D.E. 2009. Growth and Survival Rate of Mas Fish (*Cyprinus Carpio Linn*) at Different Concentrations of Regent P3g 0.3 G. *Fishing Eels*. 5 (1) : 49-54. ISSN 1858-4748.

Silea, L.M.J, and L. Masitha. 2006. Use of Bionic Fertilizer on Seaweed Plants (*Eucheuma* sp.). Faculty of Fisheries and Marine Science Unidayan, 35 p.

Siringoringo, H.H. 2013. Potential of Soil Organic Carbon Sequestion on Acacia mangium Plantation Development. R & D Center for Conservation and Rehabilitation. *Journal of Forest Research and Nature Conservation*. 10 (2) : 193-213.

Supryadi, A. 2007. Banana Cultivation Processing and Prospect Market. The Swadaya spreader. Jakarta.

Wang, K.H., Radovich, T., Pant, A. and Cheng, Z. 2014. Integration of cover crops and *vermicompost* tea for soil and plant health management in a short-term vegetable cropping system. *Applied Soil Ecology*. 82 : 26-37.

Wenno, M.R., Johanna, L., Thenu and Cynthia, G.C.L. 2012. Characteristics of Kappa Caraginan from *Kappaphycus alvarezii* at Various Harvest. *JPB Fisheries.* 7 (1) : 61-68.

Zuyasna, Halimursyadah and Saputra, C. 2010. The Effect of Super Bionic Liquid Organic Fertilizer Concentration and Peanut Varieties on Growth and Results. *Agrista Journal*. 14 (3) : 87-92.