Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.4, No.21, 2014

# Mineral Nutrient Content from Gracilaria sp. Waste as Biofertilizer on Intensive Aquaculture with Aquaponic System

Moch. Amin Alamsjah and Prayogo
Faculty of Fisheries and Marine, Universitas Airlangga, Campus C UNAIR Jl. Mulyorejo Surabaya, Indonesia.
E-mail of the corresponding author: alamsjah@fpk.unair.ac.id ; alamsjah_70@yahoo.com

**Abstract**
The aim of the research is to know the component macro and micro minerals solution fermentation, aquatic plants and fish through the analysis of chemical components, microbiology and physics for engineering technology of *Gracilaria* sp. waste as a biofertilizer on intensive fish farming with aquaponic system. Macro mineral concentrations (N, P, K, Ca, Na) and micro minerals (Fe and I) fermented solution increase based on long incubation, while the concentration of Cl tend to be difficult due to the low concentration of Cl was measured during fermentation is done. On aquatic plants and fish tests also found elevated concentrations of macro and micro minerals during the process of cultivating the aquaponic conducted, unless the concentration of Cl and I are relatively low because of the concentration of the measured is not generated (< 0.001 ppm). Media water in the aquaponic system still show a response good for aquatic plants and fish cultivated in the aquaponic system, although during treatment discoloration, smell or cloudiness media water, but for treatment in plastic packaging invisible teratology products biofertilizer on condition storage good in the indoor and outdoor, and refrigerator.
**Keywords:** mineral, *Gracilaria* sp. waste, aquaponic

## 1. Introduction

Most of Indonesia's coastal community dwellers that worked as fishermen, fishermen profiles where Indonesia is generally not so much explore the aquatic resource. The fishing activities only dwell on the activity of catching fish as well as the traditionally highly dependent on natural conditions, whereas at the moment do not fish season or weather conditions which do not allow doing fishing activity fishermen are often not found. Alternative community empowerment resource exploration through the efforts of coastal waters is indispensable as a business model that allows increasing the well-being of coastal communities.

Ilknur & Cirik (2004) and the Basmal (2011) mentioned that the benefits of seaweed not only as food but as material utilization as a pharmaceutical ingredients or raw materials industry also need to be explored further. Seaweed produced wastes are usually only allowed to pile up in the landfill. Although harmless, these waste deposits could potentially give rise to pollution problems, especially if the landfill is not capable of handling the waste produced (Saputra, 2011). Fertilizer from seaweed waste has more value that element nutrients macro among nitrogen (N), phosphor (P), potassium (K), and micro nutrient composed of Fe, B, Ca, Cu, Mn and Mg are expected to meet the needs of the plant. Sutejo (2002) mention the use of fertilization in plants that live in the waters still very rarely done. Aquatic plants planting Media combined with intensive fish farming even shrimp all at once in a single container maintenance system known as aquaponic. The basic core of aquaponic system is the optimum water supply for each commodity with recirculation system utilizing. Aquaponic technology systems is emerging as an answer to the problems of the more difficult it is to get the appropriate source of water for fish farming, particularly in the narrow land (Nugroho & Sutrisno, 2008). It is also possible fits when applied on the coastal area, where the fishermen with limited land and capital are able to optimize waste seaweed as enriched probiotics and products as well as intensive fish farming on biofertilizer of aquaponic systems. Making organic fertilizer made from sewage main seaweed can also be made into a fairly lucrative business fields. The magnitude of the potential of agriculture in Indonesia became a large market share for organic fertilizer products (Saputra, 2011). The use of seaweed fertilizer organic base material as in Indonesia have not been much utilized its considerable potential and whereas Indonesia is rich in varieties of seaweed, which is estimated at 555 types (Anggadireja *et al*., 2006), of whom is *Sargassum* sp. and *Gracilaria* sp. seaweed is known to contain many of the micro-nutrient iron, boron, calcium, copper, khlor, potassium, magnesium, and manganese. Basmal (2011) also revealed the results of an analysis that shows the content of nitrogen of seaweed reaches 1.00%, phosphor 0.05%, potassium 10.00%, calcium 1.20%, magnesium 0.80%, sulfur 3.70%, copper 5 ppm, iron 1200 ppm, manganese 12 ppm, zinc 100 ppm, boron 80 ppm, organic compounds 50-55%.

Aquaponic technology is basically divided into two sections, namely the maintenance of fish as the staple technology of cultivation and maintenance of plants. Despite the efforts of planting vegetables is a side business, but turned out to have a crucial role in supporting business success subject maintenance of fish because the plant serves as the filter or filter the water that provides a medium for the growth of good fish. With these filters, the content of toxins that are often produced from aquaculture in the form of ammonia can be reduced by

up to 90% of the existing levels so that the water is still worthy of reuse as a medium in the maintenance of fish (Nugroho & Sutrisno, 2008). The purpose of this research is knowing components of macro and micro mineral solution fermentation, aquatic plants and fish through analysis of component chemicals, microbiology and physics (test stability form, color, odor and cloudiness) by using engineering technology waste seaweed biofertilizer as in cultivation intensive aquaculture with aquaponic system.

## 2. Materials and Methods

### *2.1 Preparation of Research Equipment*

The equipment used in the study are washed with detergent and rinsed with clean water, then washed again with chlorine 12 ppm, then washed with clean water and dried in the sun. Each container is placed on the rack with a research position on design research.

### *2.2 Preparation of Seaweed*

*Sargassum* sp. and *Gracilaria* sp. used is seaweed harvest wastes that come from the rest of the harvest of farmed cultivation or plant waste results in seaweed. Then conducted the process of making fertilizer with a small cut in the depressed to take which could be summarized. Furthermore, the liquid waste is fermented seaweed and analyzed in a lab to find out levels of macro and micro minerals.

### *2.3 Fermentation technology of Seaweed Waste Liquid*

The liquid which has obtained from process preparation waste seaweed above is carried out fermentation by using brood dominated by bacteria fermentation *Lactobacillus* sp. Fermentation is transformation of organic matter into another form by using microbes (Judoamijoyo *et al*., 2003). Microbes do fermentation process by means of converting organic complex matter to be simple molecules (Amri, 2007). The composition of the number of bacteria which contained the results of the preliminary test consists of $8.7x10^5$ CFU/mL, Actinomycetes (phosphate bacteria) $7.5x10^6$ CFU/mL, yeast $8.5x10^6$ CFU/mL and photosynthesis bacteria (Rhodopseudomonas). This process begins with the mixing of *Sargassum* sp. and *Gracilaria* sp. waste liquid as many as 500 mL and mixed with a solution of fermentation bacteria of *Lactobacillus* sp. (commercial product) with the dose 5 mL, then it was stirred. The liquid is put into a sealed container and fermented for 1 week. This is in accordance with the opinion of Inckle *et al*. (2005) explaining that the fermentation time between one to two weeks. Fermentation periods adapted to the desired treatment. Laboratory analysis conducted again after the fermentation process to know the levels of N and P levels.

### *2.4 Cropping Media of Aquaponic System*

The planting medium used in the study is combined with intensive fish farming system with aquaponic (Thimen, 2005; Kohar *et al*., 2004). Waste liquid seaweed manure fermented included in each tandon (concentration 1%; 0.75%; 0.5%; 0.25%; 0%).

### *2.5 The Eligibility Test of Physics, Chemical, Biological Components and Packaging*

Test the feasibility components of physics, chemistry and biology as well as the packaging of the product biofertilizer results from waste technology engineered seaweed refers to Test ways of raw water and waste water in East Java (1990) issued by the Bureau of the Community Population and the Environment Secretariat of the Region of Province East Java. Feasibility test of physical components of biofertilizer products from waste technology engineering results of seaweed include the test temperature, color, odor, turbidity, and total dissolved solids. Test the temperature of the product in biofertilizer measure directly through the thermometer inside the packaging tube with the span of time per week/month. Color test is done by comparing the color of the sample product biofertilizer with a solution of Platinum-cobalt scale units with Pt-Co as a color standard. Examination is carried out by spectrophotometry through creation of calibration curve in order to read the color standard scale working solution of 2.5, 5, 10, and 25 with a wavelength of 355 nm. An example of a product in advance is filtered with a filter paper porous 0.45 µm. Testing conducted with the span of time per week/month. The odor test is done by using the organoleptic method of assessment of panelists. Testing conducted with the span of time per week/month. On the test method used gravimetric dissolved solids, i.e. by doing the weighing weight of dissolved solids in the sample product that is stuck on a porous filter paper 0.45 µm and dried at 103-105$^oC$ temperature up to gained the weight remains. Testing conducted with the span of time per week/month. Feasibility test of chemical components of probiotics enriched from engineering technology waste seaweed include pH test, test macro and micro components, BOD and COD. Testing conducted with the span of time per week/month. Test the pH of the product results from engineering probiotics enriched sewage seaweed is done by the method of potensiometri. Determination of the levels of N-Total done by micro-Kjeldahl spring modified, i.e. by weighing 10 mL solution and insert into the pumpkin measure out 100 mL and thins with aquadest up to the limit. Take 10 mL of the solution formed and put into 500 ml Kjeldahl flask and add 10 ml of $H_2SO_4$ (93-98%

non-N). Add a mixture of 5 g of $Na_2SO_4$-HgO (20: 1) to the catalyst. Boil until clear sample and continue boiling 30 seconds, after cold followed by washing of the Kjeldahl flask with walls in aquadest and boil again for 30 minutes. After cooling, add 140 ml of aquadest and 35 ml of NaOH and $Na_2S_2O_3$ granules-zinc. Then do the distillation, the distillate which accommodated as many as 100 mL in an erlenmeyer flask containing 25 mL of a saturated solution of boric acid and a few drops of the methylen blue indicator. Next, do a titration solution obtained with 0.02 HCl and calculate the total N samples. The amount of total N mg/mL = [(mL of HCl x N HCl)/mL of sample solution] x 14,008 x f; where f is the dilution factor. Determination of the levels of P is done by means of weighing the sample as much as 2 g and moves in a glass cup and adds 7.5 mL solution of Mg-nitrates. Heats of solution over electric heating at temperatures up to 180$^oC$ concentrated. Move the sample solution into the muffle temperature 300$^oC$ until the residue is not black. Then refrigerate and add 15 mL of concentrated HCl and dilute with aquadest. Move again into the pumpkin measure out 250 mL and dilute up to the limit. Take 100 mL sample solution obtained and transferred into a glass cup 250 mL. Add up of concentrated $NH_4OH$ to get the deposits and dissolve by adding concentrated $HNO_3$ to the solution becomes clear. Add 15 g of ammonium-nitrate and heats the water bath to above a temperature of 65$^oC$ and add 70 mL of a solution of molibdat, then silence for up to 60 min. Check out the deposition by taking 5 mL of supernatant and add 5 ml of a solution of molibdat, further stirring until no more precipitate forms. When the deposition is completed it is necessary to filter out and wash it with aquadest. Then dissolve back into the sediment filter paper by adding a solution of $NH_4OH$ (1: 1) and hot water to clean a filter paper. The volume of filtrate and washing the last results must not be more than 100 mL of filtrate. Washing and neutralize the results with concentrated of HCl, and add 15 mL of a mixture of magnesia in the burette with speeds of 1 drop per second. After being silenced for 15 min, adding 12 mL concentrated of $NH_4OH$ and leave it for 2 h. Supernatant poured over the ash-free filter paper and washes the sediment in a glass cup with diluted ammonia to non chloride. Dry the filter paper and precipitate in a crucible to retrieve a white residue. Cool off in the exicator and weigh heavy residue as $Mg_2P_2O_7$. The weight calculated by the formula weight of $P_2O_5$ (g in 100 mL solution) = 0.6377 x $Mg_2P_2O_7$ weight (g). The test macro components and elements of Ca, which is contained in a product enriched probiotics into the target analysis through the titrimetri method. Ethylene diamine tetra acetic acid (EDTA) when added to sample products containing Ca will join. Some indicators will provide a color change when all Ca have formed a complex with EDTA at pH 12-13. Micro component test is taking target Fe analyzer, which Fe analysis method is done by using spectrophotometry. Fe ions in the atmosphere of heat and acid are reduced by hidroksilamin hydrochloride into ion ferro. Ferro with 1.10 fenantrolin to form khelat fenantrolin ferro compounds at pH 3.2-3.3. Colors that formed the raw color compared against a known simply applied by spectrophotometry at a wavelength of 510 nm. On analysis of BOD, the product samples analyzed by using titration with Winkler. Measurement of dissolved oxygen before and after incubation by Winkler-enhanced method. Dissolved $O_2$ in the sample product set with the addition of alkaline ions $Mn^{2+}$ in circumstances which would be oxidized to MnO(OH). The addition of potassium iodide and pickling will exempt the equivalent amount of iodium oxygen in a sample of the product, which then freed in iodium titration with a solution of sodium tiosulfate used a raw indicator amylum. COD analysis done with the method of reflux and titrimetri. Organic substances which oxidized with a solution of acid of $K_2Cr_2O_7$, further advantages of $K_2Cr_2O_7$ at back titration with salt ferro ammonium sulfate by using ferroin indicator. Feasibility test of microbiology is based on the amount of bacteria with a calculation of total plate count (TPC). Testing conducted with the span of time per week/month. Feasibility test of the durability of the packaging to the influence of physics, chemistry and biology that are derived from the product of engineering technologies ' waste of seaweed. Testing conducted with the span of time per week were performed at room temperature (25-30$^oC$), the temperature of the refrigerator (<25$^oC$) and temperature out door (>30$^oC$) imposed on the enriched biofertilizer products from waste technology engineering results of seaweed.

*2.6 Identification of The Type and Amount of Probiotic Bacteria*

Probiotic bacterial isolates in culture media on the isolation of GYP (Glucose – Yeast extract – Peptone) so that the composition of the 10 g of glucose, 10 g of yeast extract, 5 g of pepton, 2 g of beef extract, 1.4 g Na-acetate. $3H_2O$, 5 mL of salt solution (0.1 g of $MgSO_4.7H_2O$; 0.1 g of $MNSO_4.4H_2O$; 0.1 g of $FeSO_4.7H_2O$; 0.1 g of NaCl; 50 mL aquadest), 0.5 g of tween 80, 20 g of agar, and 1 L of water. After the sterilization, added 0.075 mg of CaCO3/mL medium. Selection of *Lactobacillus* sp. by analyzing the number of isolates that have characters preeminence tolerance of low pH. Test the tolerance of low pH is done by changing the growth media enriched results in isolates of fermentation waste of seaweed with a MRS broth (pH<2.5). Media turbidity measuring by a spectrophotometer at a wavelength of 600 nm, after incubation for 0, 24, 24 and 72 h.

*2.7 Ichtyotoxicity*

10 mL of aqueous waste fermentation of seaweed in the centrifuge at 1,000 x g for 15 min. The supernatant is concentrated by using rotary evaporation. Bioassay for detection of toxicity of extract is done by using the larval

catfish (*Clarias batrachus*). Bioassay carried out inside each container 200 mL culture with the addition of 1 mL of extract and conducted observation for 24 h.

*2.8 Data Analysis*

Analysis of the data using analysis of Variance (ANOVA) with the design of the research was Complete Random Design (RAL) to know of any difference in treatment. If there is a difference in treatment then performed a test distance of Duncan with a degree of belief of 0.05 to tell the difference between all the treatments (Kusriningrum, 2008).

## 3. Results and Discussion

Feasibility test of chemical components from biofertilizer of waste technology engineering results of seaweed include macro and micro components-test and test the pH. Testing conducted with the span of a week. Macro mineral concentrations (N, P, K, Ca, Na) and micro minerals (Fe and I) fermented solution increase based on long incubation, while the concentration of Cl tend to be difficult due to the low concentration of Cl was measured during fermentation is done. The resulting products provide the availability of macro minerals (Ca and Na) and micro minerals (I) with a high concentration of > 30 ppm. On water plants also found increases in the concentration of macro and micro minerals during the process of cultivating the aquaponic conducted, unless the concentration of Cl and I are relatively low because of the concentration of the measured is not generated (< 0.001 ppm). Special micro mineral concentration I noted that it is necessary until the 21st day of aquatic plants haven't been able to absorb the mineral micro-I in the amount of the significant, though the results of macro and micro component test solution from waste fermentation seaweed *Gracilaria* sp. proved to have enough content (38.66±0.04 mg/L) in the 21st day. Based on testing of components of macro and micro minerals in fish also showed a rise in the concentration of macro and micro minerals during the process of cultivating the aquaponic conducted, unless the concentration of Cl and I are relatively low because of the concentration of the measured is not generated (< 0.001 ppm). Feasibility test of microbiology is based on the amount of bacteria with a calculation of total plate count (TPC). Testing conducted with the span of a week. The amount of the *Lactobacillus* sp. bacteria on during treatment indicates the density of the cell that needs to done fermenting. Test the stability of shape, colour, odour and turbidity that is done on the product waste engineering biofertilizer enriched seaweed with a span of a week.Test of temperature, colour, odour and turbidity that is performed on products ' waste engineering results of seaweed with a span of a week. The water media in the aquaponic system still show good response for aquatic plants and fish are cultivated in the system of aquaponic, although during the treatment changes the color, smell and turbidity of water media. On cultivating aquaponic system unidentified impaired growth of aquatic plants and fish in stress conditions. Feasibility test of the durability of the packaging to the influence of physics, chemistry and biology that are derived from the product of engineering probiotics enriched technology waste seaweed.Testing conducted with the span of a week.

During treatment in bottle plastic biofertilizer product not seen abnormality on storage conditions in both the indoor and outdoor spaces, and refrigerator. The development of fish farming technology entered the era of globalization that tends to maintain the balance of the ecosystem, which supports carrying capacity, go green, natural resource conservation, energy efficiency, the use of human resources and operational costs as well as engineering technology which ensures durability and food safety. Food safety and security here is intended as an effort to ensure the quality of food production, as well as in terms of diversification of food, food distribution, food processing technologies and food policy. Model of fish farming with the use of aquaponic strongly support system for fish farming technology goal globally with emphasis on orientation technology of environmentally friendly fish farming, in accordance with the statement of Diver (2006) stating that the aquaponic system gives the assurance of fish farming technology with biointegration pattern of growth or hydroponic plant vegetables simultaneously. The concept of space and time-saving cultivation and utilization of waste (residual feed and excretion of results) that have undergone recycling and recirculation so that it can be utilized optimally for plants are also cultivated.

On the other hand, the plant became a substance capable of being biological filter so that it is able to eliminate the poison substances appear and guarantee to supply oxygen is more assured in the aquaponic process. The involvement of microbial bacteria also able to produce enzymes that help the process of breaking down complex compounds into simpler compounds that can eventually become an organic element which is easily absorbed by the fish as well as plants with better. Pramono (2011) mentions that the cycle developed in the aquaponic provide mutually beneficial effects (mutualism symbiosis) between the fish and the plants cultivated simultaneously. Tyson *et al.* (2004, 2008a, b) also mentioned that the integration of hydroponics with aquaculture system into aquaponic cultivation system can balance the pH levels in plants, fish and bacterial nitrification. Specifically, Roosta & Ghorbani (2011) do comparison hydroponic and aquaponic cultivation system with related growth rate, oil and mineral deposits. Alamsjah (2013) has been making a research relevant relation integration waste seaweed *Gracilaria* sp., *Lactobacillus* sp. and phytoplankton of *Chlorella* sp.

collaborated in order to support the process of aquaponic until it able to analyze the amount of bacteria of *Lactobacillus* sp. in the process of fermentation to the media various waste seaweed, the difference of growth in plants water, and the average growth of long narrow leaves, wide leaves, long stems and roots as well as the growing number of leaves of aquatic plants. Growth analysis of fish associated with specific growth rate, the absolute long growth of fish, domination of plankton and the quality of water for the aquaponic system executed.

The optimal dose for probiotic application from the wastes of seaweed *Gracilaria* sp. which gives the best results in growth of fish and aquatic plants that are cultivated is the treatment by administering liquid fermentation of waste seaweed 0.5%. The role of *Lactobacillus* sp. strongly determines the success of fermentation waste of seaweed as delivered by Hidayat *et al.* (2007) which stated that the bacterium *Lactobacillus* sp. can be used as an acidic proteolytic because fermenters that can generate peptides and amino acids. This was confirmed by Pujaningsih (2005) statement that fermentation is a process of decomposition of organic material by microorganisms includes the parser so that it changes into simple compounds. The bacterium *Lactobacillus* sp. is a gram positive bacteria are facultative anaerobic and is mainly lactic acid bacteria that are able to outline the components of carbohydrate, such as lactose and other sugars to lactic acid. The bacterium *Lactobacillus* sp. is apparently able to synergize with the presence of liquid waste *Gracilaria* sp., where Choi *et al*. (2012) declared the existence of natural antibacterial materials is selective as it is produced as a secondary metabolite of seaweed that is able to stop the illegal activities of pathogenic bacteria but still allow beneficial bacteria growth. Fardiaz (1997) also reported that the fermentation allows the formation of acids that are able to extend the save products and prevent the growth of pathogenic microorganisms. Tyson *et al*. (2007) reported that nitrification bacteria convert fish wastes into $NO_3^-$ to be utilized by the plant. Increase the rate of nitrification will enhance the ability of the density of fish and plant nutrient absorption. The advanced research of observing the exploration component of macro and micro minerals as part of efforts enriched nutrient elements so that the resulting product can serve as a biofertilizer. On the existence of a measurable increase in fermentation solution concentration of macro minerals (N, P, K, Ca, Na) and micro minerals (Fe and I) based on the fermentation time, while the concentration of Cl tend to be difficult due to the low concentration of Cl was measured during fermentation is done.

Interestingly, the resulting biofertilizer products provide the availability of macro minerals (Ca and Na) and micro minerals (I) with a high concentration of >30 ppm. The presence of Ca was strongly influenced by chemical reactions involving $CO_2$, whereas in this case the $CO_2$ resulting from the respiration of plants and fish as well as part of the process of decomposition of organic matter. The $CO_2$ reacts with $H_2O$ so that it is formed $H_2CO_3$. Effendi (2012) mentions when $H_2CO_3$ through waters on the basis of calcareous rocks, anorthite ($CaAl_2Si_2O_8$) or gypsum ($CaSO_4.2H_2O$) containing the Ca will then form $Ca(HCO_3)_2$. The Ca in the aquaponic produced through a process of unravelling the complex compounds into simpler compounds from waste seaweed that has been fermented. Winarno (1996) mentioned that the mineral content of seaweed *Gracilaria* sp. contain Ca of 0.4-1.5%. Ca $(HCO3)_2$ is soluble and resulted in the waters become hard (hard water) with a pH range of 7-9, so that the resulting acidity levels in the process of fermentation and pH 3.75 can be normal (pH 7) and give a positive impact to the growth of aquatic plants and fish that are farmed. Conditions with a pH range of 7 also tend to be more productive so that the available nutrient elements are able to optimally absorbed and in supporting survival rate level of fish or aquatic plants. Cole (1988) mention that the waters of the poor will be poorer will also usually Ca content of other ions needed by aquatic organisms. The levels of Ca in fresh waters typically less than 15 ppm, while in the waters around the rocks are carbonates between 30-100 ppm. On the sea waters, Ca levels could reach 400 ppm whereas on condition very concentrated salt water (brine) can reach 75,000 ppm (McNeely *et al*., 1979). Ca levels can be decreased if the Ca experienced a deposition of $CaCO_3$ (presipitation) became, as a result of rising temperatures, photosynthesis and decrease of $CO_3$.

Ca is the element of life for all living things, which are really acting in the formation of bones and the permeability of the cell wall settings. Ca also plays in the construction of the plant cell structure and improvement of soil structure (Effendi, 2012). Cole (1988) reported that aquatic animals or plants which require a Ca in its growth called calciphiles, among others, Pelecypoda, Gastropod and Rotifers (e.g. *Brachionus* sp.), otherwise aquatic animals or plants not liking existence Ca called calciphobes, such as Cladocera *Holopedium gibberum*.

Na is one of the main elements of alkali was also obtained in the aquatic ecosystem and are affecting important cations overall balance of cations in water. Effendi (2012) mentions that almost all compounds Na is easily soluble in water and reactive. Generally, the source of Na in the waters is albite ($NaAlSi_3O_8$), nepheline ($NaAlSiO_4$), halite and mirabilite ($Na_2SO_4.10H_2O$). Na salts used in the industry of industrial waste and domestic causes as well as anthropogenic sources of Na. In such research, the sources confirmed breakdown Na organic compounds into simple compounds containing Na result of fermentation waste of *Gracilaria* sp. seaweed. Winarno (1996) mentions the mineral content of Na is a high level group of red algae of different types of seaweed with a range of 0.1-7.9%. Cole (1988) mentions that almost all natural waters contain levels of Na varies between 1 ppm to thousands of ppm, even levels of Na on the sea waters can reach more than 10,000 ppm.

Levels of Na in a natural freshwater less than 50 ppm while the conditions of very concentrated salt water (brine) can reach 25,000 to 100,000 ppm (McNeely *et al.*, 1979). Improvement of Na in the soil can change the structure of the soil and affect plant growth. The balance of Na, Ca and Mg determines the waters into a place that is optimal for the growth of aquatic plants and fish that are farmed.

Micro minerals are also produced in high concentrations among fish though and iodium water plants only absorb in low doses I (< 0.001 ppm). The iodium source of the biofertilizer products derived from seaweed, which decompose waste during the process of fermentation. Winarno (1996) mentioned that the levels of iodium on red algae range from 0.1-0.2% while in the brown algae ranges from 0.1-0.8%. Despite the presence of iodium as micro minerals but iodium instrumental in component of thyroid hormones, thyroxine and tri-iodo-thyronine are very essential in metabolic speed settings on all processes in the body. Improvement of macro and micro minerals such as N, P, K, Mg, Na, Cl, and Fe was instrumental in the process of growth of aquatic plants and fish are cultivated. Effendi (2012) mentioned that the primary ions (major ions) in waters other than Ca, then K, Mg, Na, Cl and S also very dominant presence in the waters as a supporter of the productivity of the water. Cole (1988) reported that the K elements for the growth of life including plants and animals. Liquid plant cell contains K more than Na, however Na levels at animal cell fluid exceeds the levels of K. Waters with the ratio of Na: K less than 10 is toxic for aquatic organisms are few. Mg is the alkali metals whose existence is quite abundant in natural waters. Ca and Mg is the main constituent of hardness. Mg is not toxic even profitable for liver function and the nervous system. However excessive levels of MgSO4 may result in anesthesia on vertebrate and invertebrate organisms. In plants, chlorophyll in Mg of substance so that the color green leaves can perform photosynthesis with optimal due to the presence of Mg that meets your needs.Cl ions are usually is found in the waters of the sea and vary according to climate. Haslam (1995) reported that levels of Cl in the waters of temperate moist (humid) less than 10 ppm while the waters in the semi-arid and arid (dry) can reach hundreds of ppm. Davis and Cornwell (1991) mentions that the Cl is not toxic to living things, especially in the setting of osmotic pressure of the cells. Ion contained in the least amount of (minor ions) naturally found in the waters of the ions of nitrogen (N), phosphorus (P), and iron (Fe). Nitrogen and its compounds are though scattered widely in the biosphere but very little presence in waters (Effendi, 2012). Nitrogen fixation in advance should experience be $NH_3$, $NH_4$ and $NO_3$ before utilized by living creatures (Dugan, 1972). Nevertheless, Azetobacter and Clostridium bacteria and blue green algae can use gas $N_2$ are directly from the air as a source of nitrogen, otherwise most of the aquatic organisms make use of nitrogen is not in the form of gas, but in the form of inorganic nitrogen ($NH_3$, $NO_2$, $NO_3$). On the other side, nitrogenous organic is a form of nitrogen tied to organic compounds, covering protein, polypeptide, amino acids, urea ($H_2NCONH_2$), where levels nitrogenous organic in natural waters usually around 0.01 ppm. A source of nitrogen organic in waters derived from decomposition process. Nitrogenous be in seaweed waste solution derived from nitrogen organic in the form of protein. Ito & Hori (1989) mention that content protein dried seaweed 5-35 %. Levels nitrogenous organic depopulate based on time, as do fermentation process, where nitrogenous organic conversion to ammonia ($NH_3$). When $O_2$ suffices then $NH_3$ will be oxidized to $NO_2$ and $NO_3$. The next major $NO_3$ is a form of nitrogen in the waters of the nutrient elements for the growth of plants and algae. The process of changing $NO_2$ and $NO_3$ changes via nitrification, the oxidation of $NH_3$ to $NO_2$ where done by Nitrosomonas bacteria, while the oxidation of $NO_2$ to $NO_3$ performed by Nitrobacter bacteria (Novotny & Olem, 1994). Dugan (1972) mention a phosphate ($PO_4^{3-}$) is a form of phosphorus that can be utilized by plants. Phosphorus is also an element of life for plants and algae so that these elements become the limiting factor for plants and algae as well as greatly affect aquatic productivity. Davis & Cornwell (1991) also mentioned that there is a positive correlation between levels of phosphate total with chlorophyll a. Effendi (2012) reported that phosphorus in the transfer of energy in the cells, for example in ATP (Adenosine Triphosphate) and ADP (Adenosine Diphosphate). Ortophosphate is a product of ortophosphate acid ionization is a form of simple water (Boyd, 1988), in which case ortophosphate is a form of phosphorus that can be utilized directly by aquatic plants while the polyphosphate must undergo hydrolysis to form ortophosphate before it can be used as a source of phosphorus. Brown (1987) mentions that at the time of anaerobic, phosphate bonded with ferri ($Fe_2(PO_4)_3$) experienced reduction of iron ion ($Fe^{2+}$) are soluble and releasing phosphates into the water so as to increase the presence of phosphate in the water. The case that occurred during the fermentation process is done so that the phosphate levels increased during treatment. Fe including elements of life for the organism, which in plants as a constituent of chlorophyll, and cytochrome and acting in enzyme systems and electron transfer in photosynthesis. The amount of the bacteria *Lactobacillus* sp. during treatment showed relatively stable cell densities in the range above $10^4$ CFU/mL and relatively constant cell density on $10^5$ CFU/mL. This means the amount of bacteria that thrive on the phase adaptation on day 0, and measurable on the 7$^{th}$ day until 21$^{st}$ (phase of lag exponential/logarithmic), and which was marked by an increase in metabolic activity and the number of cells in a state of balanced growth. In these conditions the average cell number and needs of metabolites is needed are at constant conditions. Through the fermentation of waste as well as the addition of seaweed molases (part of carbohydrates) as a carbon source for the fulfillment of the nutrients for bacterial growth is the result of complex compounds into a solution of salts of inorganic nitrogen ($KNO_3$) and

organic nitrogen (proteins and amino acids). Bacteria need minerals (Na, K, Mg, Fe), even in the process of fermenting bacteria also need water to sustain metabolic function and its growth. On the other hand, the bacteria need carbon to meet growth and energy, in the form of inorganic carbon ($CO_2$) and organic carbon (carbohydrate). Water media in the aquaponic system also still show good response for aquatic plants and fish are cultivated in the aquaponic system, although during the treatment changes the color, smell and turbidity of water media. Thing to note that is not identification water plant growth disorders and conditions of the stress on the fish. Nuisance growth of aquatic plants can be measured from the decline in the pace of growth, while the condition of stress on fish seen from ichtyocity test as previous research (Alamsjah, 2013). During treatment in bottle plastic are not seen abnormality biofertilizer product on storage conditions in both the indoor, outdoor spaces, and refrigerator. Despite that observations made on the durability of the packaging still needs to be continued until the expiry time in the know use of biofertilizer products produced.

## 4. Conclusion

Macro mineral concentrations (N, P, K, Ca, Na) and micro minerals (Fe and I) fermented solution increase based on long incubation, while the concentration of Cl tend to be difficult due to the low concentration of Cl was measured during fermentation is done. The resulting biofertilizer products provide the availability of macro minerals (Ca and Na) and micro minerals (I) with a high concentration of more than 30 ppm. On aquatic plants and fish tests also found elevated concentrations of macro and micro minerals during the process of cultivating the aquaponic conducted, unless the concentration of Cl and I are relatively low because of the concentration of the measured is not generated (< 0.001 ppm). The amount of the bacteria *Lactobacillus* sp. during treatment indicates the density of the cells (>$10^4$ CFU/mL) which meet the needs for it does fermentation. The water in the aquaponic system still show good response for aquatic plants and fish are cultivated in the aquaponic system, although during the treatment changes the color, smell and turbidity of water media. During treatment in bottle plastic are not seen abnormality biofertilizer products on storage conditions in both the indoor, outdoor spaces, and refrigerator. Furthermore, the need to do more research about probiotics and enriched biofertilizer products scale laboratory and field as well as the packaging technology using a macro and micro analysis of other minerals as well as test the resilience of the packaging until the expiry period is known to use of the product resulting biofertilizer.

## References

Alamsjah, M.A. (2013), “Gracilaria sp. Waste, Lactobacillussp. And Chlorella sp. Integration on Intensive Aquaculture with Aquaponic System”, *Journal of Natural Sciences Research* 3(11), 66-77.

Amri, M. (2007), “Pengaruh Bungkil Inti Sawit Fermentasi Dalam Pakan Terhadap Pertumbuhan Ikan Mas (*Cyprinus carpio L.*)”. Fakultas Perikanan dan Ilmu Kelautan. Universitas Bung Hatta. Padang.

Anggadireja, J. T., Zatnika, A., Purwoto, H. & Istini, S. (2006), ”Rumput Laut”. Penebar Swadaya. Jakarta. hal 39-47.

Basmal, J. (2011), „Rumput Laut Bahan Pupuk Organik Prospektif“. http://www.sinartani.com. 14/03/2001. 2 p.

Boyd, C.E. (1988), “Water Quality in Warmwater Fish Ponds”. Fourth Printing. Auburn University Agricultural Experiment Station, Alabama, USA. 359 p.

Brown, A.L. (1987), “Freshwater Ecology”. Heinemann Educational Books, London. 163 p.

Choi, J.S., Ha, Y.M., Joo, C.U., Cho, K.K., Kim, S.J. & Choi, I.S. (2012), “Inhibition of Oral Pathogens and Collagenase Activity by Seaweed Extracts”, *J. Environ. Biol.* 33(1), 115-121.

Cole, G.A. (1988), „Textbook of Limnology“. Third Edition. Waveland Press, Inc., Illinois, USA. 401 p.

Davis, M.L. & Cornwell, D.A. (1991), “Introduction to Environmental Engineering”. Second Edition. Mc-Graw-Hill, Inc., New York. 822 p.

Diver, S. (2006), “Aquaponic-Integration Hydroponic with Aquaculture. National Centre of Appropriate Technology”, United States Department of Agriculture’s Rural Bussiness Cooperative Service.

Dugan, P.R. (1972), “Biochemical Ecology of Water Pollution”. Plenum Press, New York. 159 p.

Effendi, H. (2012), “Telaah Kualitas Air Bagi Pengelolaan Sumber Daya dan Lingkungan Perairan”. Penerbit Kanisius. Yogyakarta.

Fardiaz, S. (1992), “Mikrobiologi Pangan I”. Gramedia Pustaka Utama, Jakarta.

Haslam, S.M. (1995), “River Pollution and Ecological Perspective”. John Wiley and Sons, Chichester, UK. 253 p.

Hidayat, D. (1985), “Pakan Ikan (Makanan Ikan)”. Yasaguna. Jakarta. hal. 15-21.

Ilknur, A. & Cirik, S. (2004), “Distribution of *Gracilaria verrucosa* (Hudson) Papenfuss (Rhodophyta) in Izmir Bay (Eastern Aegean Sea)”. *Pakistan Biol Sci.* 7 (11) : 2022-2023.

Inckle, M., Peter, D.S., Tim, T. & Tom, V. (2005), “The Preparation and Use of Compost”. Agromisa Foundation. Wageningen. Netherlands. pp. 11-12.

Ito, K. & Hori, K. (1989), “Seaweed: Chemical Composition and Potential Foods Uses”. *Food Reviews*

*International* 5, 101-104.
Judoamijoyo, A. (2003), "Probiotik Akuakultur". Gadjah Mada University Press. Yogyakarta.
Kohar, I., Hadjo, P.H., Jonatan, M. & Agustanti, O. (2004), "Study Kandungan Logam Pb dalam Batang dan Daun kangkung (*Ipomoea Reptans*) yang direbus dengan NaCl dan Asam Asetat". *Makara, Sains*. 8(3):85-88.
Kusriningrum, R.S. (2008), "Perancangan Percobaan". Fakultas Kedokteran Hewan, Universitas Airlangga. Airlangga University Press. Surabaya. pp. 5-69.
McNeely, R.N., Nelmanis, V.P. & Dwyer, L. (1979), "Water Quality Source Book, A Guide to Water Quality Parameter". Inland Waters Directorate, Water Quality Branch, Ottawa, Canada. 89 p.
Novotny, V. & Olem, H. (1994), " Water Quality: Prevention, Identification, and Management of Diffuse Pollution". Van Nostrand Reinhold, New York. 1054 p.
Nugroho, E. & Sutrisno (2008), "Budidaya Ikan dan Sayuran dengan Sistem Akuaponik". Penebar Swadaya. Jakarta.
Pramono, B. T. (2011). Akuaponik Solusi budidaya Ikan pada Lahan Terbatas. http://taufikbudhipramono.blog.unsoed.ac.id. 27/03/2011.
Pujaningsih, R.I. (2005), "Identifikasi Vegetasi Pakan Alami Anoa (*Bubalus* sp)", In: Proceeding of The 6th International Symposium-cum-Workshop by SEAG. Gadjah Mada University and the University Consortium Georg-August-University Göttingen.University of Kassel and Philipps University Marburg. Yogyakarta. August 22-26. 2005.
Roosta, H.R. & Ghorbani, F. (2011), "Investigation of The Growth and Development, Essential Oil and Minerals Content in Two Species of Mint in Hydroponics and Aquaponics". *J. Sci. & Technol.* Greenhouse Culture. Vol.2 No.7. Ishafan Univ. Technol. Iran.
Saputra, D. R. (2011), "Aplikasi Bioteknologi Pemanfaatan Limbah Rumput Laut". *http://www.gudangreferensi.com*. 4/6/2011. 9 pp.
Sutejo, M. M. (2002), "Pupuk dan Cara Pemupukan". Rineka Cipta. Jakarta.
Thimen, L, Preston, T.R., Thao., Cong, B.V. & Hoi, D.N. (2005), "On Farm Evolution of The Effect of Different Fertilizers on Water Spinach (*Ipomoea aquatica*) yields, and of including water spinach and catfish oil in diets For Fattening pigs in the Mekong Delta of Vietnam". Workshop, 23-25 May 2005. Mekarn – CTU. Vietnam.
Tyson, R.V., Simonne, E.H., White, J.M. & Lamb, E.M. (2004), "Reconciling Water Quality Parameters Impacting Nitrification in Aquaponics: The pH Levels". *Proc. Fla. State Hort. Soc.*117: 79-83.
Tyson, R.V., Simonne, E.H., Davis, M., Lamb, E.M., White, J.M. & Treadwell, D.D. (2007), "Effect of Nutrient Solution. Nitrate-Nitrogen Concentration, and pH on Nitrification Rate in Perlite Medium". *Journal of Plant Nutrition*. 30 (6): 901-913.
Tyson, R.V., Simonne, E.H., Treadwell, D.D., Davis, M. & White, J.M. (2008[a]), "Effect of Water pH on Yield and Nutritional Status of Greenhouse Cucumber Grown in Recirculating Hydroponics". *Journal of Plant Nutrition*. 31 (11): 2018-2030.
Tyson, R.V., Simonne, E.H., Treadwell, D.D., White, J.M. & Simonne, A. (2008[b]), "Reconciling pH for Ammonia Biofiltration and Cucumber Yield in a Recirculating Aquaponic System with Perlite Biofilters". *HortScience* 43 (3): 719-724.
Winarno, F.G. (1996), " Teknologi Pengolahan Rumput Laut". Pustaka Sinar Harapan, Jakarta.

Table 1. Component Minerals and pH on Fermentation Liquid Biofertilizer Products

| **Macro Mineral** | **Treatment (ppm)** | | | |
|---|---|---|---|---|
| | **$M_0$** | **$M_1$** | **$M_2$** | **$M_3$** |
| N | < 0.001 | 0.16±0.05 | 0.21±0.09 | 0.36±0.07 |
| P | < 0.001 | < 0.01 | < 0.01 | 0.01±0.00 |
| K | < 0.001 | 1.26±0.11 | 1.37±0.01 | 1.53±0.28 |
| Ca | < 0.001 | 10.77±0.95 | 75.35±3.27 | 78.63±3.35 |
| Mg | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| Na | < 0.001 | 3.57±0.20 | 11.12±0.70 | 59.36±1.32 |
| Cl | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| **Micro Mineral** | | | | |
| Fe | 0.15±0.07 | 0.41±0.05 | 0.72±0.16 | 0.76±0.03 |
| I | 25.18±0.39 | 26.24±0.60 | 30.98±3.40 | 38.66±0.04 |
| **pH** | 3.75±0.50 | 3.75±0.50 | 3.75±0.50 | 3.75±0.50 |

Description: M0 = fermented solution on 0 day; M1 = fermented solution on 1 day; M2 = fermented solution on 3 days; M3 = fermented solution on 5 days

Table 2. Mineral Component on Water Cress Plant (*Ipomoea aquatica*)

| Macro Mineral | Treatment (ppm) | | | |
|---|---|---|---|---|
| | $P_0$ | $P_1$ | $P_2$ | $P_3$ |
| N | 65.28±1.57 | 65.32±0.97 | 66.08±1.36 | 66.71±1.04 |
| P | 39.74±0.05 | 39.83±0.01 | 39.87±0.57 | 40.01±1.03 |
| K | 1.89±0.01 | 2.02±0.03 | 3.01±0.41 | 3.02±0.57 |
| Ca | 4.88±0.36 | 5.03±0.81 | 5.05±0.97 | 5.67±1.21 |
| Mg | 3.40±0.72 | 3.94±1.02 | 4.01±0.91 | 4.14±0.65 |
| Na | 19.84±0.17 | 20.12±1.31 | 22.55±1.27 | 26.77±0.48 |
| Cl | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| **Micro Mineral** | | | | |
| Fe | 3.95±0.07 | 4.02±1.38 | 4.56±1.73 | 4.77±0.18 |
| I | < 0.001 | < 0.001 | < 0.001 | < 0.001 |

Description: P0 = water cress plant on 0 day; P1 = water cress plants on 7 days; P2 = water cress plants on 14 days; P3 = water cress plants on 21 days

Table 3. Macro and Micro Minerals Component on Catfish (*Clarias batrachus*)

| Macro Mineral | Treatment (ppm) | | | |
|---|---|---|---|---|
| | $F_0$ | $F_1$ | $F_2$ | $F_3$ |
| N | 170.15±1.53 | 170.65±1.94 | 171.19±0.38 | 171.27±0.97 |
| P | 168.07±1.91 | 168.13±0.17 | 168.19±0.13 | 169.01±1.28 |
| K | 4.76±0.91 | 5.17±0.83 | 5.29±1.01 | 5.33±1.11 |
| Ca | 1.91±0.31 | 2.14±1.04 | 2.28±1.17 | 3.02±0.99 |
| Mg | 2.88±1.02 | 3.03±0.19 | 3.48±1.46 | 4.03±1.58 |
| Na | 14.87±2.21 | 15.83±1.14 | 15.94±0.02 | 16.02±0.93 |
| Cl | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| **Micro Mineral** | | | | |
| Fe | 6.88±0.91 | 6.93±1.08 | 7.56±0.04 | 8.01±0.59 |
| I | < 0.001 | < 0.001 | < 0.001 | < 0.001 |

Description: F0 = catfish on 0 day; F1 = catfish on 7 days; F2 = catfish on 14 days; F3 = catfish on 21 days

Table 4.The Amount of *Lactobacillus* sp. Bacteria in Aquaponic Water Media

| Bacteria Number (CFU/mL) | Treatment | | | |
|---|---|---|---|---|
| | $B_0$ | $B_1$ | $B_2$ | $B_3$ |
| *Lactobacillus* sp. | $0.1 \times 10^4$ | $1.1 \times 10^5$ | $3.2 \times 10^5$ | $3.5 \times 10^5$ |

Description: B0 = *Lactobacillus* sp. bacteria on 0 day; B1 = *Lactobacillus* sp. bacteria on 7 days; B2 = *Lactobacillus* sp. bacteria on 14 days; B3 = *Lactobacillus* sp. bacteria on 21 days

Table 5. The Physics Component Test in Aquaponic Water Media

| Physics Component | Traeatment | | | |
|---|---|---|---|---|
| | $W_0$ | $W_1$ | $W_2$ | $W_3$ |
| Stability of shape | Remain liquid (not to clot and settles) | Remain liquid (not to clot and settles) | Remain liquid (not to clot and settles) | Remain liquid (not to clot and settles) |
| Color | Dark brown | Somewhat blackish brown | Somewhat blackish brown | Somewhat blackish brown |
| Odor | Unique (molases) | Odorless | Odorless | Odorless |
| Turbidity | Very turbid | Slightly turbid | Slightly turbid | Slightly turbid |

Description: W0 = Water media on 0 day; W1 = Water media on 7 days; W2 = Water media on 14 days; W3 = Water media on the 21 days

Table 6.The Proper Test of Packaging Endurance

| Packaging Endurance | Treatment | | | |
|---|---|---|---|---|
| | **$Pkc_0$** | **$Pkc_1$** | **$Pkc_2$** | **$Pkc_3$** |
| Room temperature (25-30$^o$C) | Stable (no expansion of products) | Stable (no expansion of products) | Stable (no expansion of products) | Stable (no expansion of products) |
| Refrigerator temperature (<25$^o$C) | Stable (no expansion of products) | Stable (no expansion of products) | Stable (no expansion of products) | Stable (no expansion of products) |
| Out door temperature (>30$^o$C) | Stable (no expansion of products) | Stable (no expansion of products) | Stable (no expansion of products) | Stable (no expansion of products) |

Description: $Pkc_0$ = biofertilizer products in plastic bottles on 0 day; $Pkc_1$ = biofertilizer products in plastic bottles on 7 days; $Pkc_2$ = biofertilizer products in plastic bottles on 14 days; $Pkc_3$ = biofertilizer products in plastic bottles on 21 days

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

## CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

**Prospective authors of journals can find the submission instruction on the following page:** http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

## MORE RESOURCES

Book publication information: http://www.iiste.org/book/

### IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar