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CHEMICAL NUTRIENT CONTENT OF SARGASSUM LIQUID FERTILIZER PRODUCED FROM SHIPHON-CONNECTED DECOMPOSERS

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ABSTRACT

This study was to analyze the micro- and macro-nutrient level of Sargassum liquid fertilizer (SFL) produced from siphon-modified decomposers and to evaluate their effects on the growth of *Ipomoea aquatica*. The twelve siphons are modified in various diameters, namely small (S), medium (M), and large (L), immersed height, 16 (code 1), 18 (2), 20 (3), and 22 cm (4), were set up to allow the gas-related byproducts of the decomposition translocating from the decomposer to an aeration cylinder. According to N, P, and K content of 1.47, 0.07, and 0.34%, respectively, decomposer L3 produced the most promising SFL compared to others. In addition, the liquid products exhibited better effects on the growth of *I. aquatica* including root length, total height, and freshness. As the modified siphon-like connectors may play role in the transportation of gas due to the modified force and pressure factors, the siphon-like tubes could be applied to improve the production of SFL.

Keywords: *Sargassum polycystum,* Micro- and Macro-nutrient, Liquid Fertilizer, Siphon, Decomposer.

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INTRODUCTION

Fertilizers are manifestly essential to the maintenance of soil fertility, acceleration of plant growth, and increase of yields. Synthetically derived fertilizers have been thought for being fast-acting to me*et al*l these criteria. However, given that they are water-soluble and non-biodegradable, excessive chemicals could contaminate the environment. Organic fertilizers, on the other hand, could be a choice due to being biodegradable, non-toxic, non-polluting, and harmless to the ecosystems.[1] *Sargassum polycystum* CA Agardh. naturally growing in Lange coastline (5 ° 31'31.5 "North Latitude and 95 °11'41.8" East Longitude, Aceh Besar) has been reported to have electrical conductivity, total dissolved solids, and proximate parameters above the average values of some brown seaweeds.[2]

These indicators might imply its highly promising potential as a raw material for bio-fertilizers.[3] Some concerns need to be put in place regarding the drawbacks of Sargassum Liquid Fertilizer (SLF). Basmal and Vijayanand *et al* reported that the SLF extracted from strong alkaline solvents and hot water has low nutrient content, i.e. N and P.[1,4,5] Other works remarkably demonstrated increased levels of some nutritional components by utilizing effective microorganisms 4 (EM4) and *Bacillus subtilis* in the composting process.[4-7] However, the nitrogen content of the product was still below 3–6 %, the national standard of the Indonesian Agriculture Ministry (Permentan 70/SR.140/10/2011).[4,7]

A further effort to increase the nitrogen levels of SLF needs to be done. As physical control plays a major driving force in a decomposition process[8], the design of air and energy flows in the incubator might provide the required fermentation temperature for the degradation of the algal cell walls. Therefore, this study focuses on the design of the composter drum employing the siphon principle by optimizing the pipe attached to a simple anaerobic incubator. Specifically, it modifies some physical parameters of the pipe *viz*. the diameter, length, and height of the curve. To evaluate the products, measurements of chemical nutrients and growth effects toward *Ipomoea aquatica* have been carried out.

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EXPERIMENTAL

This study used a hot plate, atomic absorption spectrophotometer-AES (AAS-AES, Agilent MP), oven, pH meter (Orion 4 star), UV-Vis spectrophotometer (Shimadzu, Japan), Kjedhal, and perchloric acid analysis apparatus, burette, 600-mL mineral water bottles, and blender (Miyako). Materials were *S. polycystum* CA Agardh., commercial EM4 starter, post-harvest banana (*Musa paradisiaca*) trunk, fish waste of *Euthynnus affinis* from Lampulo market, $K_2Cr_2O_7$, $HClO_4$, H_2SO_4, HNO_3, phenolphthalein, NaOH, glass adhesive, raw material required for glass making (silica sand, Na_2O from soda ash, CaO from limestone, dolomite (MgO), and feldspar (Al_2O_3)), and water. All chemicals were purchased from Sigma-Aldrich (USA).

Sample Preparation

Glass reverse U-shaped siphons were prepared following Nurhayati *et al*.[9] with varied diameters of 0.5 cm (small), 1 cm (medium), and 1.5 cm (large) and length and immersed in the sludge of 16 (code 1), 18 (2), 20 (3), and 22 cm (4) were used to connect 600 mL of bottles to another half-filled water bottles. As the decomposition controls, non-siphon equipped with opened and closed bins were applied. The sample decomposition was adapted from Sedayu *et al*.[4] using EM4 2% solution (± 20 mL per kg of seaweed) and a mixture of banana trees and fish waste (5:1).

Analysis of Nutritional Content

The level of C was measured by UV-Vis spectrophotometry at λ 561 nm following Walkey and Black method.[10] The total nitrogen and phosphorous content were determined using the Kjeldahl method while the potassium level was measured with inductively coupled plasma (ICP) following the procedure of Dipietro *et al*. with minor changes.[11] The levels of nutrient were determined by atomic absorption spectroscopy following the procedure of the American Public Health with necessary adjustments.[12]

Growing Effects Observation

The protocol of analysis of SLF effects on *I. aquatica* growing in polybags was necessarily modified from Vijayanand *et al*.[1] The aqueous SLF solution (1.5%, 50 mL) was sprayed on each polybag for 3 days for a period of 30 days. Another polybag without treatment was prepared as a control. The growth parameters including the root length, shoot length, total height, freshness, and dry weight were determined on the last day.

RESULTS AND DISCUSSION

Macronutrient Content

The macronutrient level of the samples shown in Fig.-1 fluctuated. According to the national regulation, all macronutrient extracted from this study was still lower than the required range. On the other hand, the L3 outcome was higher than those reported by Basmal *et al*.[13], Sedayu *et al*.[4], and Loppies & Yumas[7], commercial *S. vulgare* extract (ACTION®)[14] except for K levels, and Asmara *et al*.[2] except P. Although the percentage of C-organic were below 6%, the maturity and stability of the leachate appear to be achieved as accepted C/N ratio should be no more than 20.[15]

Micronutrient Content

Sample L3 possessed the most promising level (378.08 ppm) of Fe, relatively higher than acidic extracts of *S. asperifolium*, *S. dentifolium*, and *S. linifolium*[16] and *S. wightii*[1]. Sulphur, however, was recorded significantly less than those in products of heat-assisted extraction: *S. muticum* and *Nanantans*[17] and *S. vulgare* (ACTION®)[14]. Mn, Cu, and Zn were below the national minimum level while more concentration was observed in sample L3 compared to the SFL reported by Bharath *et al*.[18] Interestingly, *S. crassifolium* extract from Pasikudah (Sri Lanka) has been reported to have a quantitatively similar level of Mn, Cu, and Zn to this study.[19] Moreover, the pH values of all samples were observed between 7 and 9. This could imply beneficial effects on organic agricultural plants.[18,19,20]

The Effect of SFL on the Growth of *I. aquatica*

As shown in Figure-3, the measured parameters fluctuated. Some samples demonstrated promoting effects on the plants. Sample S2, M2, and M4 predominantly affected the elongation of the root, total height, and weight, respectively. The sample S2 has high nitrogen content according to Figure-1. On the other hand, the longest shoot was observed in the treatment with SFL from opened decomposer. Sample L3 showed a potential effect on the weight.

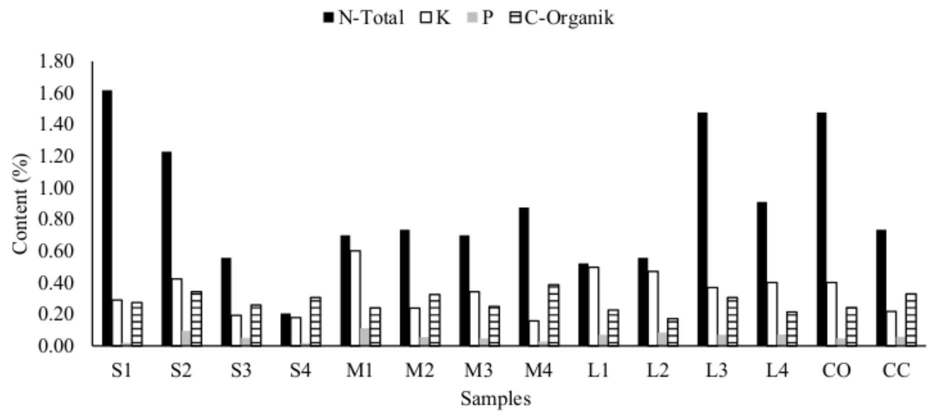

Fig.-1: Bar Graphic Representing Macronutrient Content of SLF from Modified Decomposers (S = small; M = medium; L = large, CO = opened control, CC = closed control; 1, 2, 3, and 4 denote the length of the siphons immersed in the sludge of 16, 18, 20, and 22 cm, respectively)

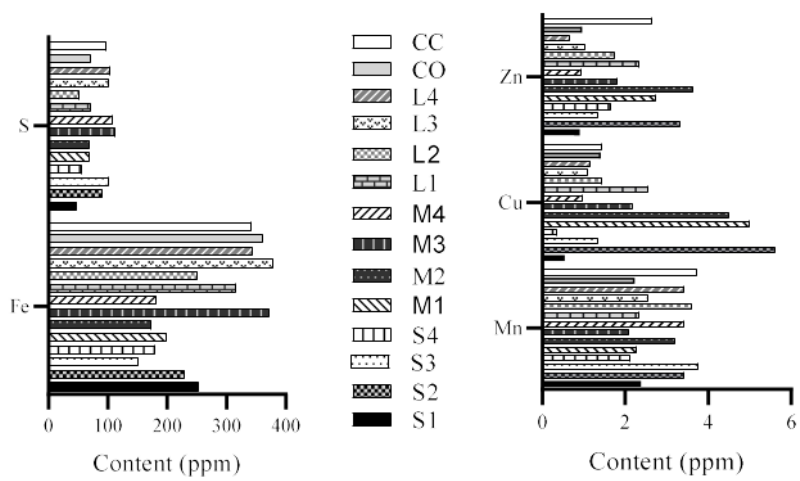

Fig.-2: Microelement Content of Composted SFL Extracted from Siphon-Modified Decomposers

The Physical Perspective of the Siphon

As a tube, the area (*A*) for a siphon-like cylinder with *h* I as height (cm) can be written as follows:

$$A = a_b h$$

$$A = 3.14\ \frac{1}{4} d^2 h \qquad (1)$$

Since the density of gas flowing through the cylindrical tube could be neglectable, a hydrostatic pressure approach could be applied. Due to the identical type of the cylinder, the cross-sectional A for both segments I and III readily follow equation (1).

On the other hand, segment II is different because it has a triangular geometry-like shape that needs to consider a trigonometric analysis. Therefore, the *A* of segment II could be expressed as:

$$A = a_b h\ sin\theta$$

$$A = \frac{3.14}{4} d^2 h \sin\theta \qquad (2)$$

The greater F will result in increased mobilized matters. When the CO_2 concentration gets saturated, the gas flows to the aeration bottle to maintain the thermal equilibrium. This hypothesis might be the reason to expect L4 as the model with the largest gas flow capacity. However, the macronutrient data showed that the most optimal decomposition process occurred in the L3 decomposer. A smooth transition could be postulated to be essential during the mobilization of byproducts while a rapid change might lead to a decreased activity rate due to physiological alterations.

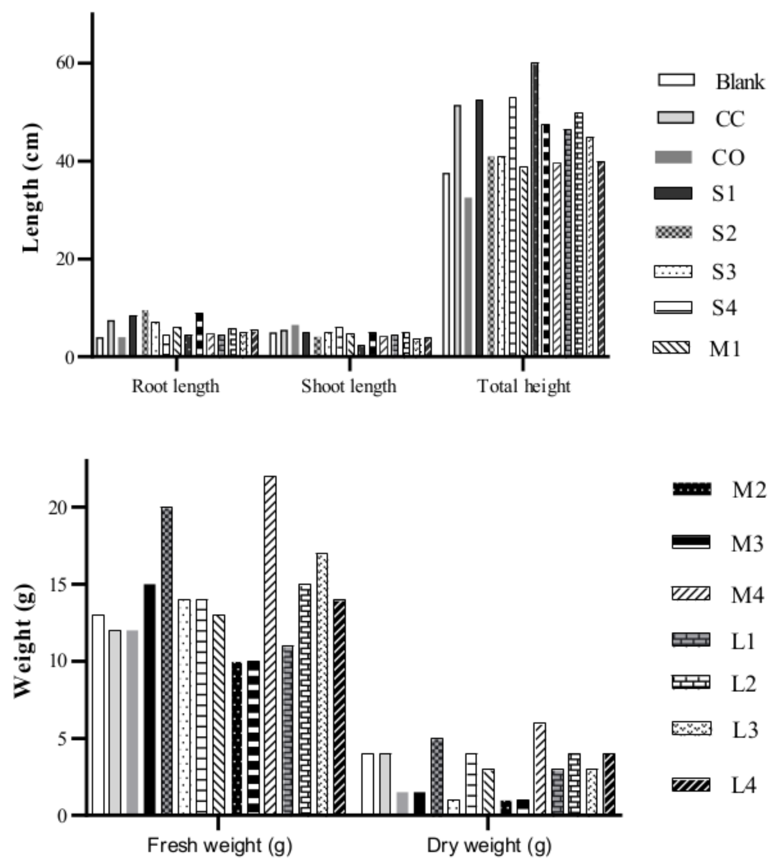

Fig.-3: Growth Variables Observed in the Application of the SFL to *I. aquatica* on 30 Days Old Plant

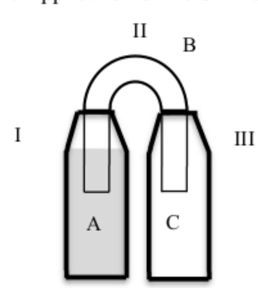

Fig.-4: A Simplified Model of the Siphon-Modified Decomposer, A = Decomposer Cylinder; B = Siphon-Like Connector; C = Aeration Cylinder

CONCLUSION

This study confirms that sample L3 produced from the decomposer equipped by siphon with d = 1.5 cm and l = 20 cm could be considered a promising SFL. Moreover, the liquid products demonstrate a positive impact on the growth of *I. aquatica.* Further studies are essential to confirm the growth hormone level to gain more comprehensive insight.

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