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A Novel of Liquid Organic Fertilizer from Degraded Batik Dye and Tofu Effluents on Hydroponic Systems†

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Abstract: *Aspergillus* sp. is a microscopic fungus that is able to properly degrade batik dye effluents. The innovation of making liquid organic fertilizer (LOF) from degraded batik dye and tofu effluents can be a sustainable solution in overcoming environmental problems and advancing the agricultural sector, especially in the aspect of organic fertilizer for agricultural crop productivity. Organic substances of tofu waste and degraded batik dye effluents have the potential to support organic fertilizer elements. The results showed that the addition of LOF from degraded batik dye and tofu effluents on mung bean plants (*Vigna radiata*) affected the best growth response on plant height, wet weight, root length, and seed viability rate.

Keywords: Liquid organic fertilizer; degraded batik dye effluents; tofu effluents; *Aspergillus* sp.; hydroponic systems

1. Introduction

Synthetic Batik dye effluents have a high level of toxicity [1]. Synthetic Batik dye effluents could disturb the photosynthetic processes of plants [2]. *Aspergillus* sp. is one of the fungi species that is used to degrade Batik dye effluents [3,4]. One example, *Aspergillus* sp. 3, could be able to decrease the levels of Total Dissolved Solids (TDS), Electrical Conductance (EC), Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), Chemical Oxygen Demand (COD), temperature, and pH of the batik effluents, also could decrease the concentration of oil or fat that contain in Batik dye effluents [5]. The potential test result of degraded batik dye effluents by *Aspergillus* sp. 3 does not give a toxic effect on the growth of corn and green beans crops [3]. The previous research has shown that the length of roots and stems of *Zea mays* and *Vigna radiata* which are watered by degraded batik dye effluents is longer than that watered by water (control) [3,4,5]. This research showed that degraded batik dye effluents have potential as liquid organic fertilizer (LOF). The degraded result became simple compounds that could be used as macronutrient sources for plants, therefore, it doesn't harm when dispose of to the environment.

Besides batik effluents, currently, tofu industries in Indonesia are significantly developing and resulting in tofu effluents [6]. Analyzes tofu effluents were conducted and showed the substances such as carbohydrate, protein, fat, N, P, K, Ca, Mg and Fe. The substances on tofu effluents have the potential as LOF [7]. Tofu effluents are the effluents from the tofu production process in the form of wastewater and contain nutrients N 1.24%,

P_2O_5 5.54%, K_2O 1.34%, and C-Organic 5.8% which are essential nutrients for plants [8]. Tofu liquid waste can be processed into LOF with the help of Effective Microorganism-4 (EM4) [9]. Nutrients in tofu effluents have the potential as LOF.

Nowadays, organic farming is a concern in some countries, especially in Indonesia. Organic farming requires the usage of organic fertilizer as the alternative nutrients solution [10]. The basic materials of organic fertilizer come from dead living things such as animal waste, plants waste, or household waste that experienced the process of decay by decomposing organisms [11]. LOF comes from plants and animals that fermented and produced the liquid. LOF contains nutrients such as Phosphor, Nitrogen, and Potassium that are important for plants and repair soil nutrients [12]. The application of LOF on hydroponics systems is more efficient than the soil medium system [9,13].

AB mix is one of the LOF that is very popular in the hydroponic system due to high macronutrient sources for plants such as NH_4 (14 ppm), NO_3 (150.5 ppm), H_2PO_4 (38.75 ppm), and K (253.5 ppm) which are very good for plant growth in hydroponic systems [14]. Thus, the parameters of plant height, wet weight, and dry weight had a very good effect on lettuce plants compared to only the addition of LOF treatment of tofu waste [15]. Therefore, in this research, we would like to obtain another macronutrient source instead of AB mix. There will be a new innovation of LOF as macronutrient sources from degraded batik dye and tofu effluents.

This research aims to determine the ability of LOF from degraded batik dye and tofu effluents in enhancing the growth of mung bean and to know the best effect of its LOF in enhancing the growth of mung bean based on the LOF concentration given.

2. Materials and Methods

2.1. Media and effluents

Media used in this research is Potato Dextrose Agar (PDA) containing: 20g dextrose, 20g agar, 200g potato, and aquades 1000mL and Potato Dextrose Broth (PDB) containing: 20g dextrose, 200g potato, and aquades 1000 mL. Batik dye effluents were taken from Sokaraja, Banyumas Regency, Central Java, Indonesia, Tofu effluents were taken from Tofu Factory Kaliputih in Purwokerto, Banyumas Regency, Central Java, Indonesia.

2.2. Isolate

Aspergillus sp. 3. The species completely has been identified and got paten as *Aspergillus sclerotiorum* G.Pn strain [16]. The morphological character of this species has the golden yellow colony with a 45 mm in diameter colony and constructed by vesicle, metulae & philiades, foot cell with spore diameter in the range 2.5 µm - 3.0 µm [3,16].

2.3 Re-culture of Aspergillus sp. 3.

Re-culture of fungi *Aspergillus* sp. on PDA medium for 7 days at 28^{o}C. After that, 5 plugs of *Aspergillus* sp. 3 will re-culture again on PDB medium for 5 days at 28^{o}C and put on shaking incubator at 70 rpm.

2.4. Degradation process

The degradation process will do by adding 100 mL Batik dye effluents into the PDB medium containing *Aspergillus* sp. 3. The degradation process will be done after 4 hours on the shaking incubator at 70 rpm that shown by changing color from dark blue into clear yellowish The result of the degradation was obtained by the filtration.

2.5. *Making LOF*

LOF of degraded Batik and Tofu effluents in a ratio of 1:1 which are homogenized and mixed with 10% EM4 and brown sugar. Fermentation is carried out for 7 days anaerobically. LOF is used after the fermentation process.

2.6. *LOF application in a wick hydroponic system*

LOF applied on mung bean seeds in hydroponic by wick system (Figure 1). The research method used was a completely randomized design (CRD) with the treatment of LOF concentration and each treatment has 3 replications. The treatments used in the test are T0: water without LOF, T1: AB mix (10 mL/1000 mL water, T2: LOF (20 mL/1000 mL water), T3: LOF (30 mL/1000 mL water), T4: LOF (40 mL/1000 mL water), and T5: LOF (50 mL/1000 mL water). The tests were carried out for 7 days and data were taken in the form of height, wet weight, root length, and seed viability rate.

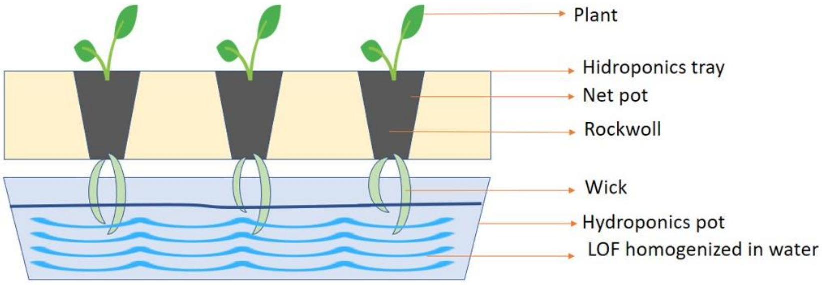

Figure 1. Hydroponic of a wick system

3. Result and Discussion

The fungi species that is used for decolorization of and degradation of batik effluent is *Aspergillus* sp. 3 (Figure 2). The species completely has been identified and got paten as *Aspergillus sclerotiorum* G.Pn strain [16]. This species as superior microfungi to decolorize batik effluent. This species is a new agent in the decolorization of batik effluent which is able to reduce the color of batik waste by 98.26% with the largest weight of mycelial. A*spergillus sclerotiorum* G.Pn strain showed the highest efficiency for degradation of effluent containing Indigosol Blue-04B and was more efficiently used for batik effluent mycoremediation [3,16].

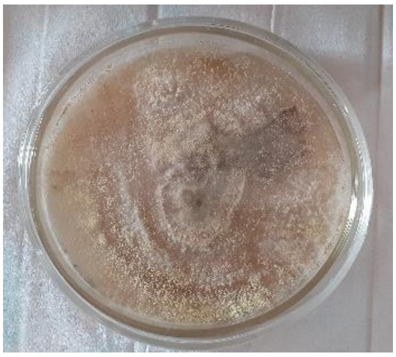

Figure 2. *Aspergillus* sp. 3

Aspergillus sp. 3 be able to degrade Batik dye effluents as proof by change of color (Figure 3 a, b). This was due to the decreased toxicity level which was indicated by the value according to the waste quality standard. Degradation of batik waste by *Aspergillus* sp. 3 was able to reduce Cr concentration from 1.1 mg/L to be <0.12 mg/L, Sulfide concentration from 2.95 mg/L to 0.5 mg/L, ammonia concentration from 127.2 mg/L to 55 .5 mg/L and the concentration of phenol from 0.33 mg/L to 0.17 mg/L, and oil-fat from 10.992.75 mg/L to 539.75 mg/L [5]. Decreased toxicity due to the degradation process by

Aspergillus sp. can be used as a reference in vitro tests on plants such as corn and mung bean.

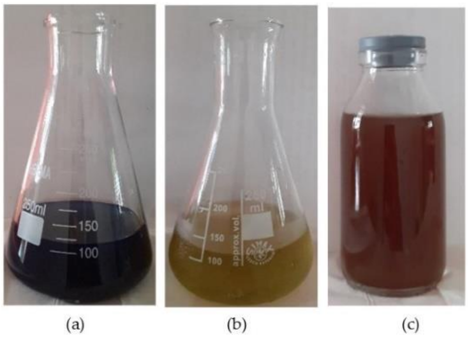

Figure 3. (a) Batik dye effluents; **(b)** Degraded batik dye effluents; **(c)** LOF

The growth of mung beans in a hydroponic system based on the application of LOF (figure 3c) from degraded Batik dye and tofu effluents were shown in table 1 and figure 4. The data on plant height showed in the figure 4 that there are no far distances in the plant height on day 1 after planting. However, on day 7 after planting, the maximum plant height was found in LOF treatment with a level of 20 mL of 19.83±0.09 cm and the shortest height is 14.21 ± 2.79 cm. The LOF treatment 20 mL showed the best effect on the plant height rather than another treatment such as water and AB mix. The related research about plants treated by degraded batik dye effluents on the length stems of *Z. mays* and *V. radiata* shown the higher than watered by water (control) [3,4,5]. The related research that the addition of 100% LOF tofu effluents concentration gave the best effect on the height of chili plants (*Capsicum annum* L.) rather than treated by low LOF tofu effluents concentration and water [17].

Table 1. Plant Height Day 7 after Planting, Root Length, Wet Weight and Seed Viability Rate at 7 Days after Planting

Type of LOF	Plant Height Day 7 (cm)	Root Length (cm)	Wet Weight (g)	Viability (%)
T0 (water: Control)	16.67 ± 0.58	11.0 ± 0.87	0.31 ± 0.04	100
T1 (AB Mix)	19.37 ± 2.51	3.09 ± 0.41	0.31 ± 0.03	100
T2 (LOF 20 mL)	19.83 ± 0.09	11.1 ± 2.32	0.37 ± 0.04	100
T3 (LOF 30 mL)	17.44 ± 4.81	7.69 ± 2.58	0.28 ± 0.09	67-100
T4 (LOF 40 mL)	14.21 ± 2.79	8.99 ± 2.92	0.28 ± 0.08	67-100
T5 (LOF 50 mL)	18.55 ± 2.89	9.33 ± 2.12	0.37 ± 0.05	67-100

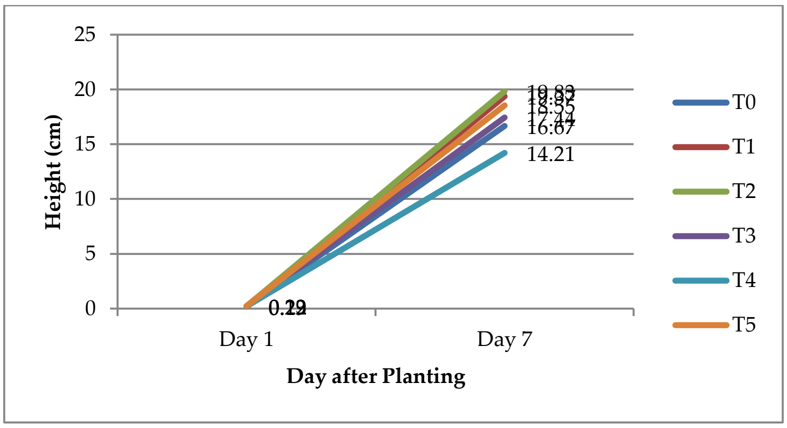

Figure 4. Graph of Plant Height at 1 Day and 7 Days after Planting

The effect of LOF addition on the wet weight, showed that the maximum plant weight was found in 2 LOF treatments with a level of 20 mL and 50 mL with the weight being 0.37 ± 0.04 g and 0.37 ± 0.05 g. The lowest wet weight showed in 2 LOF treatments with a level of 30 mL and 40 mL with the weight is 0.28 ± 0.09 g and 0.28 ± 0.08 g. This is the same with the previous research that the addition of LOF tofu waste has a good effect on the growth parameters of mung beans (e.g. plant height, number of leaves, and stem diameter) [18].

The LOF application has a good effect on the length of the roots of mung bean plants. Based on the data result, LOF with a level of 20 mL with the highest root length, which was 11.1±2.32 cm. The shortest length of the root was shown by the treatment of AB mix with the length is 3.09 ± 0.41 cm. The previous related research showed that root length growth treated with 60% tofu LOF compared to no fertilizer treatment on red spinach (Alternantheraamoenavoss) showed a goof effect due to potassium in the LOF of tofu waste that increases root elongation and improves drought tolerance [19].

The viability rate of mung bean seeds after being treated by water, AB mix, LOF 20 mL, and LOF 50 mL is 100% as shown in table 1. The viability rate of mung bean seeds after being treated LOF 30 mL and LOF 40 mL is 67%-100%. The other related research showed that Aspergillus sp.3 isolates were able to decolorize effluents up to 99.9% and decrease the toxicity level of batik dye effluents [3]. The results of the degradation treatment of batik dye effluents on corn and mung bean seeds can grow well compared to the treatment of batik dye effluents [3-4].

Figure 5. The figures show plants after 7 days treated by LOF levels. (**a**) Plants treated by water or control; **(b)** Plants treated by AB mix (T1); **(c)** Plants treated by LOF 20 mL (T2); **(d)** Plants treated by LOF 30 mL (T3); **(e)** Plants treated by LOF 40 mL (T4), **(f)** Plants treated by LOF 50 mL (T5).

The effect of LOF on plants can be seen clearly in the appearance of overall growth, i.e. plant height, root length (Figure 5). This picture proves that the presence of mixed LOF fermentation from degraded batik $_{dye}$ and tofu effluents is better than the use of water and as good as the use of AB mix in the hydroponic system on mung bean plants.

4. Conclusion

The research revealed that the addition of LOF of tofu waste and degraded batik effluents can be affected for plant height, wet weight, root length, and seed viability. The addition of LOF 20 mL showed the best responses on plant height, root length, wet weight, and seed viability sequentially 19.83±0.09 cm, 11.1±2.32 cm, 0.37±0.04 g, and 100%.

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Conflicts of Interest: The authors declare no conflict of interest.t.

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