Tofu Industrial Wastewater Treatment using Local Microorganisms Bio Activator from Banana Weevil

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Keywords: Banana Weevil, Bio Activator, Bioremediation, Local Microorganisms, Tofu.

Abstract: The tofu industry is one of the industries that produce organic waste in solid and liquid waste. The amount of organic liquid waste produced, which is directly disposed of into water bodies without going through good processing, will significantly impact the aquatic environmental ecosystem. The biological treatment of tofu industrial wastewater by utilizing microorganisms on bioremediation process using local microorganisms bio activator of banana weevil is one of the easy, cheap, and fast wastewater treatment. This study aims to evaluate the effect of bio activator volume and the bioremediation process time on Chemical Oxygen Demand (COD) content, Total Suspended Solid (TSS) content, and pH of tofu industrial wastewater in Samarinda City. Firstly, add 30, 60, 90, and 120 ml bio activator volume into 500 ml of tofu industrial wastewater and then bioremedied for two days, four days, and six days. At the end of the process, the remaining COD, TSS, and pH of tofu industrial wastewater were analyzed. The best results of COD content were 6050 mg/L, TSS content was 290 mg/L and pH was 8.16 were obtained at bioremediation process time of 6 days and 120 ml bio activator volume of local microorganisms from banana weevil addition.

1 INTRODUCTION

Liquid wastewater in the tofu industries comes from the soaking process from the washing process, and tofu printing which contains high protein and can be decomposed immediately. The liquid wastewater of the tofu industry contains organic matter such as proteins, amino acids, fats, oils, and carbohydrates in the form of suspended and dissolved solids in very large amounts, around 40% to 60%. It also contains gases such as oxygen (O_2), hydrogen (H_2O), hydrogen sulfide (H_2S), ammonia (NH_3), carbon dioxide (CO_2), and methane (CH_4) derived from the decomposition of organic matter in wastewater (Pohan, 2008).

Approximately 80 home industries are spread across several sub-districts in Samarinda City area (such as on Lumba-lumba Street, Selili Village-Samarinda Ilir District, Tanjung Street 3D, Sungai Pinang Luar District, etc.) that produces 10 tons soybeans/month. One tofu home industry can produce 20 m^3/day of liquid wastewater (Ananda et al., 2018). Tofu industrial wastewater in Samarinda contains Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), and oil/fat respectively as follows 4,583 mg/L, 7,050 mg/L, 4,743 mg/L, and 26 mg/L with pH is around 4-5 (Bangun, et al., 2013).

A large number of tofu home industries cause a large amount of organic waste to be produced and will have a significant impact on aquatic environmental ecosystems if it's directly disposed of into drainage or water bodies without prior processing. One of the easy, cheap, and fast waste treatments is the biological treatment of the tofu waste treatment process by utilizing microorganisms (Sari, et al., 2017).

Bioremediation process using local microorganisms of banana weevil could be applied because it produces many microorganisms that decompose organic compounds. The decomposer microbes are located outside and inside the banana weevil (Kesumaningwati, 2013). Banana weevil also contains high enough nutrients with a complete composition, namely: carbohydrates (66%), protein (4.35%), starch (45.4%), water and important minerals so that they can be used as raw materials for the formation of local microorganisms (Kesumaningwati, 2013).

The microorganisms found in banana weevil include *Bacillus sp., Aeromonas sp., Aspergillus nigger, Azospirillium, Azetobacter and cellulosic*

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microbes. These microbes usually decompose organic matter (Budiyani et al., 2016). In Yuliansari's (2020) study on the isolation of bacteria in local microorganisms of the banana weevil, it was explained that banana weevil consisted of pseudomonas sp bacteria which are decomposers.

The research related to the bioremediation process was carried out by Prabhakar et al., 2021 using indigenous bacterial isolate *Nesterenkonia lacusekhoensis* for removal of azo dyes: A low-cost eco-friendly approach for bioremediation of textile wastewaters. The results of this research showed that the bacterium not just decolorized dye mixture at high pH in the presence of indigenous microorganisms of wastewater but also decreased Chemical Oxygen Demand (COD). It gradually lowered the pH of the wastewater from an initial 11.0 to 8.4 during the treatment.

The other research was conducted by (Erguven et al., 2017), which has studied "The ability of *Phanerochaete chrysosporium* (ME446) on chemical oxygen demand remediation in submerged culture medium supplemented with malathion insecticide". According to this research results, the fungus has achieved 99.6, 98.8 and 98.7 % COD reduction at concentration of 50, 100 and 150 ppm respectively the end of the 15 days. It's showed that *P. chrysosporium* could be an effective bioremediation tool for treating malathion-containing wastewater.

Another study has done by Salgueiro et al., 2016 used Chlorella Vulgaris microalga as a potential candidate for removing the phosphorous and organic matter from wastewater by bioremediation process. From this study, obtained microalgae were able to remove the phosphorus concentration by more than 99%. On the other hand, the chemical oxygen demand was reduced by 71%. After nine days of cultivation, the biomass concentration increased from 0.05 to 0.57 g/L wastewater.

This research aims to evaluate the effect of bioactivator volume and the bioremediation process time on Chemical Oxygen Demand (COD) content, Total Suspended Solid (TSS) content, and pH of tofu industrial wastewater in Samarinda City.

2 METHODOLOGY

The local microorganisms bio activator from banana weevil is made through anaerobic fermentation by mixing 2 kg of the mashed banana weevil with 100 grams of diluted brown sugar and 2 liters of a washing water reservoir for ten days. Bioremediation process is carried out by adding 30, 60, 90, and 120 ml bio activator volume into 500 ml of tofu industrial wastewater (obtained from tofu home industry on Tanjung Street 3D, Sungai Pinang Luar District Samarinda City, East Kalimantan) and then bioremediated for 2, 4 and 6 days. After the anaerobic bioremediation process, they are followed by an aerobic process using an aerator to circulate the oxygen with 4 L/min flow rate of air for 2, 4 and 6 days bioremediation process time. At the end of the process, the remaining Chemical Oxygen Demand (COD) content, Total Suspended Solid (TSS) content, and pH of tofu industrial wastewater were analyzed.

3 RESULT AND DISCUSSION

Before the bioremediation process, the characteristics of tofu industrial wastewater consist of the parameters of COD, TSS, and pH, respectively as follows 14,300 mg/L, 4,170 mg/L and 3.4. The results of the anaerob-aerob bioremediation process of tofu industrial wastewater using local microorganisms bio activator from banana weevil at different bio activator volume and bioremediation process time can be seen in Table 1 and Figure 1 for COD content, Table 2 and Figure 2 for TSS content and the last Table 3 and Figure 3 for pH.

Table 1: Chemical oxygen demand analysis after bioremediation process.

Bio activator volume, ml	COD content at bioremediation process time, mg/L		
	2 days	4 days	6 days
30	12,800	9,410	8,170
60	9,900	8,700	7,260
90	9,070	8,310	6,650
120	8,646.67	7,916.67	6,050

The addition of the local microorganisms bio activator volume of the banana weevil caused the COD content to decrease quite well, as can be seen in Table 1 and Figure 1. The larger addition of bio activator volume in tofu industrial wastewater, the smaller COD content obtained. It's due to the larger the bio activator volume of addition in tofu industrial wastewater, the larger number of bacteria that could be broken down organic substances in tofu industrial wastewater. Figure 1 also shows the correlation between bioremediation process time and COD content. The longer the bioremediation process, the lower COD obtained. It's due to the longer the bioremediation process, more organic matter that can

be decomposed by decomposing bacteria so that organic matter settle and are oxidized (Haerun et al., 2018). Based on Figure 1, it can be seen that the best results of COD content were 6050 mg/L with a decreased percentage of COD content of 57.69% were obtained in addition of 120 ml volume local microorganisms bio activator with a bioremediation process time of 6 days.

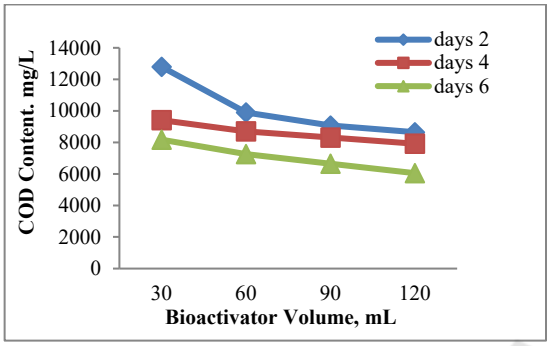

Figure 1: The effect of the local microorganisms bio activator volume and bioremediation process time on COD content.

Table 2: Total suspended solid analysis after bioremediation process.

Bio activator volume, ml	TSS content at bioremediation process time, mg/L		
	2 days	4 days	6 days
30	780	555	400
60	840	610	330
90	875	560	550
120	805	455	290

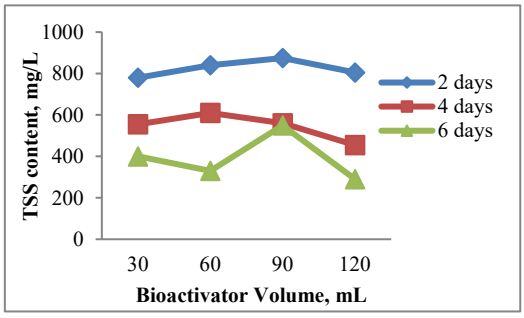

Figure 2: The effect of the local microorganisms bio activator volume and bioremediation process time on TSS content.

Figure 2 showed that over time in bioremediation process, the TSS content tends to decrease because in this phase, the microorganisms were in a phase of rapid bacterial growth, which results in a decrease in the TSS content. In this study, the larger addition of bioactivator volume in tofu industrial wastewater, it did not show consistency in the TSS content. It's due to the larger the bio activator volume of addition, and it did not necessarily indicate the larger the number of microbes. Based on Figure 2, the best results of 290 mg/L TSS content were obtained at 120 mL bio activator volume addition with a bioremediation process time of 6 days.

Table 3: pH analysis after bioremediation process.

Bio activator volume, ml	pH at bioremediation process time, mg/L		
	2 days	4 days	6 days
30	3.52	4.7	5.17
60	3.7	6.33	6.6
90	3.9	6.72	7.6
120	4.12	6.85	8.16

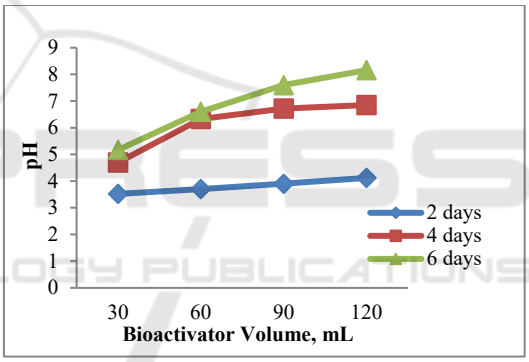

Figure 3: The effect of the local microorganisms bio activator volume and bioremediation process time on pH.

Based on Figure 3, the pH in each treatment of tofu industrial wastewater increased during the bioremediation process. The larger the bio activator volume of the banana weevil added onto tofu industrial wastewater and the longer the bioremediation process time, the pH is closer to the neutral. The increase in pH from acidic to neutral in tofu industrial wastewater was thought to be due to the activity of microorganisms both in the tofu industrial wastewater or in the local microorganisms bio activator of the banana weevil. Microorganisms experiencing a growth phase, increasing the number of groups as a result of the decomposition of sugar into ethanol so that the pH increased. The best results of pH were obtained at the addition of 30 ml, 60 ml, 90 ml and 120 ml bioactivator volume, respectively as follows 5.17; 6.6 ; 7.6 and 8.16.

4 CONCLUSIONS

1. The results of this study showed that the COD content decreased and the pH of tofu industrial wastewater closer to a neutral value as the volume addition of local microorganisms bio activator became larger. However, it did not show a consistent increase/decrease in TSS content.
2. The COD and TSS content decrease as the longer of bioremediation process time.
3. The best results of COD content were 6050 mg/L, the TSS content was 290 mg/L, and pH was 8.16 were obtained at a bioremediation process time of 6 days with the addition of 120 ml volume of local microorganisms bio activator from banana weevil.

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