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The Effect of Plant Media in the Wetland Circulation System Bioremediation Process Onthe Reduction of Bod in Tofu Wastewater Using Water Bamboo (Equisetum Hyemale)

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Abstract: *The tofu industry is a business in the food sector that has both positive and negative impacts. The positive impact is in the form of satisfying people's need for food, while the negative impact is in the form of waste that leads to environmental pollution problems. Tofu liquid waste has characteristics in the form of high pH, COD (Chemical Oxygen Demand), BOD (Biochemical Oxygen Demand), TSS (Total Suspended Solids). The purpose of this study was to determine the effect of the type and construction of different planting media on the reduction of BOD on tofu waste using water bamboo plants. The research method used was the wetland recirculating system technique. The results of the study are in the 2nd treatment which only uses plant media in the form of water bamboo, there is a decrease in BOD (Biochemical Oxygen Demand) in tofu liquid waste by 78.8%. In the 3rd treatment, which uses media in the form of water bamboo and rice field mud, there is a decrease in BOD (Biochemical Oxygen Demand) of 88.7%. Meanwhile, in the 4th treatment using media in the form of water bamboo, field mud and quartz sand, a decrease in BOD (Biochemical Oxygen Demand) of 85.0% was experienced. In the 5th treatment using media in the form of water bamboo, rice field mud and zeolite, a reduction in BOD (Biochemical Oxygen Demand) of 93.6% was achieved. Based on this, it can be seen that the use of water bamboo media, rice field mud and zeolite has a significant effect on the reduction of BOD (Biochemical Oxygen Demand) in tofu liquid waste.*
Keyword : *Water Bamboo, BOD, Tofu Wastewater*

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I. Introduction

The tofu industry is a business in the food sector that has both positive and negative impacts. On the positive side, it helps fulfill the population's need for food. However, on the negative side, it produces waste that contributes to environmental pollution. Tofu wastewater contains organic substances such as proteins, carbohydrates, and fats. In addition, improperly handled production processes may result in broken tofu pieces, which increase the amount of suspended or settled solids in the wastewater. These suspended and dissolved solids can undergo physical and chemical changes, forming toxic compounds that pollute the environment [5].

Tofu wastewater is characterized by high levels of pH, COD (Chemical Oxygen Demand), BOD (Biochemical Oxygen Demand), TSS (Total Suspended Solids), ammonia, fat, oil, nitrite, and nitrate. Therefore, wastewater treatment is necessary before it is discharged into the environment (Kasman, Riyanti, Sy, and Ridwan, 2018). In general, tofu wastewater has a COD concentration ranging from 4,000 to 6,000 mg/L and a TSS concentration of approximately 2,100 to 3,800 mg/L [8].

One method of treating tofu wastewater is biological treatment. This process utilizes microorganisms or plants to treat wastewater. Currently, various wastewater treatment technologies have been developed, one of which is the bioremediation process using constructed wetlands. According to Kangas, the use of wetlands for wastewater treatment began in the early 1970s.In general, there are two types of constructed wetland bioremediation systems: the Surface Flow Constructed Wetland, in which water flows across the surface of the soil, and the Subsurface Flow Constructed Wetland, where water flows beneath the soil surface [12].

One type of aquatic plant used in the bioremediation process of constructed wetlands is horsetail (Equisetum hyemale). Horsetail is an ornamental plant that has the ability to treat wastewater through a man-made Subsurface Flow (SSF) wetland system. This plant can be used to treat domestic wastewater. Treatment results have shown an average reduction of 86% in BOD and 84% in COD [7].

II. Research Methods

2.1. Flow Diagram

This research is classified as a true experimental study, which aims to determine the effect of the relationship between the variables being investigated. The study is expected to identify the influence of different planting media in the bioremediation process using a wetland circulation system on the reduction of BOD levels

in tofu wastewater, using horsetail (Equisetum hyemale) as the treatment plant.The research flowchart has been developed to facilitate the implementation of the study:

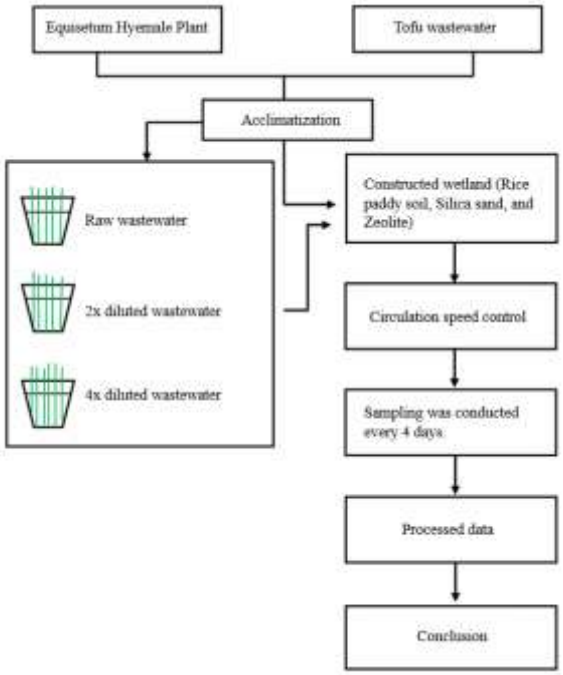

Fig. 1Flow Diagram

2.2. Research Tools

Tools used in the study of BOD reduction in tofu wastewater using water bamboo plants are as follows:
a. Nine clear jars with a capacity of 16 liters each
b. One-meter-long clear hose
c. Four pumps
d. Dropper pipette
e. Aqua bottles
f. Black plastic bags
Materials used in this study are as follows:
a. Water bamboo plants (Equisetum hyemale)
b. Tofu wastewater
c. Rice field mud
d. Silica sand
e. Zeolite stones

2.3. Research Procedure

The following is the procedure of the study:

1. Sampling of tofu wastewater was carried out using a funnel when pouring it into a jerrycan, followed by the experiment.
2. Initial measurement of BOD concentration was conducted in the laboratory.
3. Each container was prepared with diluted tofu wastewater (4x dilution, resulting in 25% concentration).
4. The diluted tofu wastewater was then circulated vertically and horizontally using a water pump into each reactor, which contained water bamboo plants (Equisetum hyemale) and different media in each container, as follows:

- Tank 1: 25% tofu wastewater
- Tank 2: 25% tofu wastewater and water bamboo plants
- Tank 3: 25% tofu wastewater, rice field mud, and water bamboo plants
- Tank 4: 25% tofu wastewater, rice field mud, silica sand, and water bamboo plants
- Tank 5: 25% tofu wastewater, rice field mud, zeolite stones, and water bamboo plants

5. BOD concentration of the tofu wastewater samples was measured using a circulation system, with each

setup containing 750 grams of water bamboo plants to achieve optimal results.
6. The treatment involved 750 grams of water bamboo plants with different contact times: day 0, day 4, day 8, and day 12.
7. Finally, BOD concentration was tested in the laboratory for each contact time variation.

III. Results And Discussion

3.1. Acclimatization

Acclimatization is one of the activities carried out on plants when introduced to a new environment. It is an adaptation effort made by an organism to adjust to a new environment it enters. The acclimatization process is conducted to determine how long the plants can survive. Plants that are able to adapt are characterized by healthy growth, the absence of wilting, and no signs of death. In this study, acclimatization was carried out for 7 days using wastewater concentrations of 25%, 50%, 75%, and 100%. Plants that did not wilt or die proceeded to the next stage, which is the wetland circulation process. After acclimatization, the plants were able to survive at a wastewater concentration of 25%. Therefore, in the wetland circulation process, a tofu liquidwaste concentration of 25% was used.

3.2. Experimental conditions.

The experiment was conducted in batch mode with a volume of 16 liters. The amount of plants used in each treatment was 750 grams. The experimental setup is shown in Figure 2.

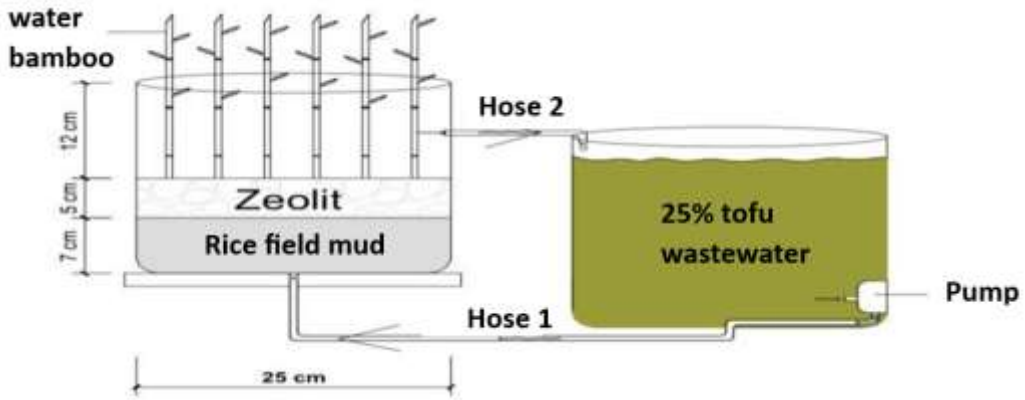

Fig. 2Wetland circulation scheme

The experiment was conducted in batch mode with a volume of 16 liters. The amount of plants used in each treatment was 750 grams. The experimental setup is shown in Figure 2.The bioremediation process was carried out for 12 days with sampling intervals of 4 days. The parameter measured was BOD

3.3. The Effect of Bioremediation Media Composition in Tofu Wastewater Using Water Bamboo Plants on BOD Reduction

In this study, five treatments (including a control) were used, as follows:
1. 25% tofu wastewater without any media (control)
2. 25% tofu wastewater with water bamboo plants
3. 25% tofu wastewater with rice field mud and water bamboo plants
4. 25% tofu wastewater with rice field mud, silica sand, and water bamboo plants
5. 25% tofu wastewater with rice field mud, zeolite, and water bamboo plants

The experiment was conducted over 12 days using a wetland circulation system. The flow rate was 0.0001481 m^3/second, and sampling was performed at 4-day intervals on days 0, 4, 8, and 12. The BOD reduction for all five treatments is shown in Figure 3.

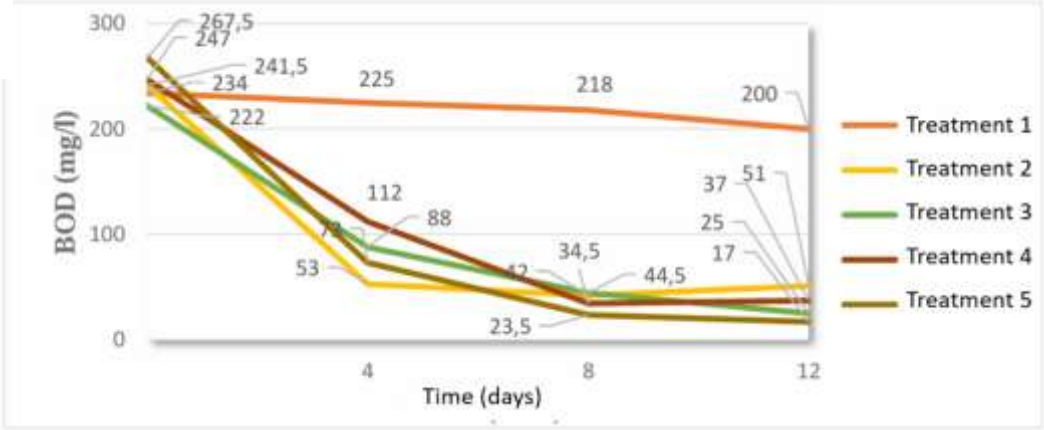

Fig. 3The relationship between bioremediation time and BOD reduction for the five treatments

Plants play an important role in supporting the removal rate of organic compounds present in tofu wastewater. Photosynthetic activity in plants can increase the level of dissolved oxygen, which is needed by microorganisms to help degrade organic compounds in the tofu wastewater [6]. Plants are capable of absorption processes that allow the movement of ions through cell membranes, including pollutants. Essentially, all substances in the soil solution can be absorbed by plant roots. Water bamboo (Equisetum hyemale) is capable of reducing pollutants contained in tofu wastewater, including achieving a BOD reduction of up to 93.6%. Therefore, it can be concluded that plants play a crucial role in wastewater treatment using a wetland circulation system.

IV. Conclusion

1. The type of growing media used in the bioremediation process affects the reduction of BOD in tofu wastewater using water bamboo (Equisetum hyemale) with a wetland circulation system.
2. The highest BOD reduction occurred in Treatment 5 (25% tofu wastewater, rice field mud, zeolite, and water bamboo), with a reduction rate of 93.6%. This treatment involved the degradation of organic matter by microorganisms present in the tofu wastewater, absorption (phytoremediation) by the roots of water bamboo, and adsorption by the porous structure of the zeolite.
3. BOD reduction in Treatment 4 (25% tofu wastewater, rice field mud, silica sand, and water bamboo) was 85.0%, in Treatment 3 (25% tofu wastewater, rice field mud, and water bamboo) was 88.7%, and in Treatment 2, which used only water bamboo plants, was 78.8%.

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