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EFFECTIVENESS OF ECO ENZYMES IN REDUCING COD AND TSS IN TOFU WASTE IN KLUMUTAN VILLAGE

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ABSTRACT

Liquid waste is increasing due to the increase in human population and the expansion of industrial activities, for example, tofu-making liquid waste. From the data of DLH Kabupten Madiun in the Tofu Rina industry, the laboratory test results are, COD 2231.1 mg/L, TSS 917 mg/L, and PH 5.69. Liquid wastewater from the outlet of the tofu factory does not meet the quality standards based on PERMEN LH No. 5 of 2014 waste for soybean businesses. The purpose of this study was to determine the effectiveness of Eco Enzyme in reducing the chemical parameters of tofu liquid waste in Klumutan Village, Saradan District. The research method is quantitative, using Quast Experiment research. Repetition was done 9 times, using the Purposive sampling technique, and data analysis in the form of Univariate and Bivariate tests used Repeated Measure Anova. The results of the study were obtained at dose and detention time, COD 5% dose (473.33), 10% dose (425) and 15% dose (359.33), TSS 5% dose (250.66), 10% dose (232.66) and 15% dose (206.66). PH level is 4, from 9 treatments. The treatment was carried out on the 10th, 15th, and 20th days. The results of statistical tests show that the longer the time and the higher the dose, the higher the effectiveness of reducing chemical parameters using Eco Enzyme. The conclusion of this study is that there is an effect on reducing COD and TSS levels with a significance value of 0.000 in tofu liquid waste and PH with a significance of 4.00, so there is no effect on tofu liquid waste using Eco Enzyme. Increase the control program for liquid waste disposal for business actors so that before the waste is discharged into the environment first treat it one way by using Eco Enzyme.

Keywords: *Eco Enzyme, Chemical Parameters, Liquid Waste*

INTRODUCTION

Tofu production waste is one type of liquid waste that is often encountered. Organic elements and chemical compounds that can harm the environment are found in the waste of the tofu-making process. The amount of liquid waste generated increases as a result of the increase in human population and the expansion of ongoing industrial activities. Waste from the tofu-making process is one example of liquid waste. Waste problems are often caused by a lack of proactive community involvement and different perceptions, some even argue that the government should be responsible for handling waste. Garbage or waste that is not managed and discharged directly into the river can change the chemical, biological, and physical properties of water to disrupt the life of aquatic biota (Ardiansyah, 2024).

Data from the Ministry of Agriculture in 2019 shows that from 2002 to 2017, the average annual consumption of tofu was 7.41 kg/capita. The tofu sector is expected to use more soybean on average by 1.78% between 2019 and 2021. Meanwhile, it is estimated that by 2021, tofu consumption will increase to 8.67 kg per capita. In Indonesia, the tofu industry is now mostly run using old-fashioned equipment, resulting in relatively high waste generation and perceived inefficient use of resources (water and raw materials). Liquid waste is generated during the washing, soaking, clumping, pressing, spilling, and cleaning stages in the tofu manufacturing process. The effluents produced by the tofu industry, namely COD and TSS, are examples of chemical properties. The COD value is a scientific indicator of the amount of

organic chemicals polluting the water. These substances can be oxidized by microbial activity, thus reducing the amount of dissolved oxygen in the water. COD levels in wastewater must meet the established quality standards. The quality standard itself is the limit or level of biological elements or other components that exist or must exist, which are in accordance with their designation (Listyaningrum, 2022).

Total Suspended Solids (TSS), or TSS for short, is a measure of water quality. When suspended solids build up in areas of severe gill abrasion, fish species are at risk of serious disease. Fish are less able to forage due to the drag caused by material moving in suspension, thus increasing the availability of these species to predators. The amount of suspended particles in the water has a significant effect on the amount of dissolved oxygen. Heat from sunlight absorbed by suspended particles increases water temperature, decreasing the ability of warm water to contain oxygen and disturbing cold-water species. TSS prevents the penetration of light, which plants need to photosynthesize, thus decreasing the amount of oxygen produced. The more suspended solids in the subsurface, the more silt settles in estuaries (Listyaningrum, 2022).

Based on Appendix XVIII of the Regulation of the Minister of Environment and Forestry Number 5 of 2014, the quality standard value of soybean processing water (tofu) is COD 300 mg/L, pH 7, and TSS 200 mg/L. Meanwhile, tofu industry wastewater has a relatively high organic matter content, with BOD levels of 5,000-10,000 mg/l and COD levels of 7,000-12,000 mg/l.

From the data of the Environmental Agency on one of the Tofu industries located in the Madiun district area, the laboratory test results are COD 2231.1 mg/L, TSS 917 mg/L, and Ph 5.69. The wastewater from the outlet of the tofu factory shows test results that do not meet the quality standards based on East Java Governor Regulation Number 72 of 2013 Appendix I Number 31 Quality Standards for Wastewater from the Soybean Processing Industry (Tofu) (Madiun District Environmental Service, 2022).

Klumutan village is home to the largest tofu and tempeh industry. Waste discharged into the river is a common public health problem associated with the tofu industry. This will lead to the deposition of solid particles of tofu waste that will dissolve in the waste liquid and accumulate to form a layer in the river. Due to improper sedimentation of the solid particles, pollution is released into the environment causing an unpleasant odor that gets worse during the dry season due to the clogging of air filters. During the rainy season, there is no problem, but when the dry season comes, a foul odor is emitted from the tofu pulp by the locals, causing great nuisance to other residents. Large amounts of water are used in the tofu production process, mostly for washing and soaking soybeans and for grinding, heating, and filtering the soybean juice. These procedures add about 15% water, and most of the remaining material comes out as wastewater. On average, it takes 10 liters of water to process 1 kg of soybeans, resulting in an average of ±3 liters of tofu business wastewater per kilogram of soybeans processed (Antika, 2020).

Wastewater discharged without proper treatment will contain pollutants that can contaminate open water sources, such as lakes, rivers, and seas, as well as terrestrial natural systems and air. The survival of biotic organisms, the preservation of nature, and human health are all negatively impacted by the contamination of air by various pollutants. As the global population grows and industry advances in various sectors, including the food business, the

need for good quality air for humans and other living things is increasing. The need for clean air is affected by this situation, and there is a threat to ecosystems due to poor water quality. As low-quality waste is generated as a by-product in increasing amounts, this impacts the need for clean air availability and jeopardizes environmental quality (Beulah and Muthukumaran, 2020).

According to Amalia et al. (2022), a large number of organic compounds have the potential to accelerate the proliferation of microorganisms in the atmosphere. The characteristics of tofu liquid waste derived from tofu processing include the presence of organic matter which, if left for several days in the open, can dissolve and decompose. Tofu wastewater usually has an average temperature between 40 to 600°C, greater than the ambient temperature. The process of agglutination (clumping) of soybean juice containing acidic properties to kill germs is what causes this tofu liquid waste to become acidic. This can result in a decrease in the dissolved oxygen content in the water. Therefore, one method to reduce chemical parameters is by using Eco enzymes made from wastewater.

An all-purpose liquid known as Eco enzymes is created when organic waste, including fruit and vegetable waste, sugar or molasses, and water, is fermented. Eco enzymes are a different type of decentralized processing aid that can be used in household wastewater treatment. Lipase, amylase, and protease enzymes are the dominant ingredients of Eco enzymes and can aid in the breakdown of contaminants in wastewater. Eco enzymes can be utilized as an alternative aid for decentralized processing in residential wastewater treatment, however, their high concentration of organic matter hinders the use of eco enzymes for total suspended solids (TDS) removal. To treat wastewater and keep it within the neutral pH range of water bodies, Eco enzymes are used. (Widyastuti et al., 2023)

Eco-enzyme is a solution to the treatment of waste organic matter. The main purpose of eco-enzymes is to accelerate the rate of decomposition. There are four types of functions that these Eco enzymes can perform: catalysis, conversion, rearrangement, and decay. Eco enzymes are a more cost-effective alternative for treating organic waste because they are readily available, accelerate the decomposition of organic matter, and use fewer resources. Eco enzymes have the ability to reduce harmful microorganisms and sludge in waste. Eco enzymes can promote the recycling of waste materials back into the soil. To reduce river water pollution and improve the quality of liquid waste from the tofu industry, the authors made a study with the title "The effectiveness of Eco Enzymes in Reducing the Chemical Parameters of Tofu Factory Liquid Waste in Klumutan Village, Saradan District". The purpose of this study was to determine the effectiveness of the use of Eco Enzym in reducing the value of chemical parameters COD, TSS, and PH in tofu industry waste in Klumutan Village, Saradan Subdistrict.

METHOD

Research Design

Throughout the research process, the researcher can use the research design as a guideline to help him achieve the predetermined research objectives. This research is a quasi-experiment with a time series design, measurements were taken after treatment, and the results were compared to observe variations in the decrease in chemical parameters of tofu industry wastewater.

Tools and materials

The manufacture of Eco enzymes uses airtight plastic reactor equipment with a volume of 5 liters, knives, fruit cutting boards, scales, funnels, containers, and filters. The materials used for making eco enzymes are fruit peel waste, 1 liter of water, and 100 grams of molasses. Tofu wastewater comes from one tofu industry in Klumutan Village, Saradan District with the largest production capacity.

Procedure

Making eco enzyme by preparing 1 liter of water. Cutting the fruit peel waste with medium size. Weighing the fruit peel waste as much as 300 grams. Putting the fruit peel waste into the reactor. Adding molasses as much as 100 grams into the reactor. Stirring and kneading the fruit leather waste until it is evenly mixed. Before the reactor is closed, cover the reactor with airtight plastic. Labeling the date of manufacture and harvest period of the eco enzyme on the reactor. Opening the reactor lid on the first and 7th day to release the fermentation gas.

In the process of applying Eco Enzymes in Tofu Wastewater in the initial analysis, 9 reactors were prepared, where each reactor was filled with 1 liter of tofu wastewater and added eco enzymes with concentrations of 10%, 15%, and 20% respectively, and then stirred to make it homogeneous. Sample testing for COD, TSS, and PH analysis was carried out on days 10, 15, and 20. Testing COD parameters using the tetrimetric method, TSS using the SNI 6989.11: 2019 method, and PH using the SNI 6989.11: 2019 method.

RESULTS AND DISCUSSION

In the research conducted on June 4, 2024, during the 10th day after treatment, the 15th day after treatment, and 20th day after Eco enzyme treatment using 9 replications (repetitions). After that, the samples were examined in the laboratory after receiving treatment, with a length of contact time on the 10th, 15th, and 20th days by measuring the chemical parameters of COD, TSS, and PH at the Magetan Sanitary Test Laboratory. The results of the study were then analyzed in Univariate and Bivariate with SPSS 16 software.

Table 1
Examination Results of Chemical Parameter Decrease in Tofu Liquid Waste Using Ecoenzyme (Primary Data, 2024)

No	Date	sample	Testing Results COD	TSS	PH
1	June 14, 2024	Dosis 5 % *Ekoenzyme*	495	270	4
1	June 19, 2024		495	250	4
1	June 24, 2024		430	232	4
2	June 14, 2024	Dosis 10 % *Ekoenzyme*	490	250	4
2	June 19, 2024		455	238	4
2	June 24, 2024		330	210	4
3	June 14, 2024	Dosis 15 % *Ekoenzyme*	470	232	4
3	June 19, 2024		320	212	4
3	June 24, 2024		288	176	4

Testing was carried out with 3 variations of eco enzyme concentration. For Eco enzyme concentrations of 5%, 10%, and 15% were carried out on Tuesday, June 14, 2024,

for Eco enzyme concentrations of 5%, 10%, and 15% were carried out on Wednesday, June 19, 2024, and for Eco enzyme concentrations of 5%, 10%, and 15% were carried out on Monday, June 24, 2024. In Table 1. there was a decrease in the value of COD parameters in all treatments when eco enzyme began to be mixed with tofu wastewater, it can be seen in one of the treatments mixing 15% fruit eco enzyme with a detention time of day 20 with an initial COD value of 470 mg/l to 288mg/l. In this study, the COD value met the quality standard. PermenLH No.5 of 2014 concerning soybean processing.

Table 1 shows a decrease in chemical parameters after treatment with Ecoenzyme doses of 5%, 10%, and 15% of tofu industry wastewater. There is the highest COD level at a dose of 5% which is 495 mg\L and the lowest value of COD levels of 288 mg/L with a dose of 15% Ecoenzyme. In the sampling of TSS parameters, there are TSS levels with the highest value of 270 mg/L at a dose of 5% and the lowest value of TSS levels with a dose of 15% ecoenzyme of 176 mg/L. And for the PH parameter in sampling with a dose of ecoenzyme of 5%, 10%, and 15% there is no change with a PH value of 4.

Figure 1
Results of the presentation of average TSS reduction levels in the form of images or illustrations (Primary Data, 2024)

Based on graph 1, there has been a decrease in COD levels from a 5% dose of 0%, a 10% dose of 1.01%, and a 15% dose of 4.8% on June 14, 2024. The decrease in the 5% dose was 0%, the 10% dose was 8.08% and the 15% dose was 12.72% on June 19, 2024. Furthermore, the 5% dose decreased by 0%, the 10% dose by 23.25%, and the 15% dose by 29.67%. So it can be concluded that the highest decrease in COD levels in using Ecoenzyme seen from the dose and residence time is at a dose of 15% on the 20th day of 29.67%, while the lowest decrease in TSS levels occurred in the treatment with a dose of 5% at 0%.

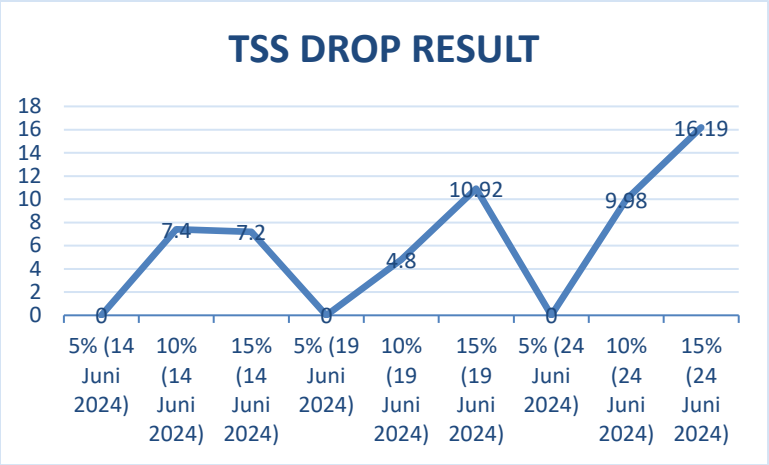

Figure 2
Results of the presentation of average TSS reduction levels in the form of images or illustrations (Primary Data, 2024)

Based on graph 2, there has been a decrease in TSS levels from a 5% dose of 0%, a 10% dose of 7.4%, and a 15% dose of 7.2% on June 14, 2024. The decrease in the 5% dose was 0%, the 10% dose was 4.8% and the 15% dose was 10.92% on June 19, 2024. Furthermore, the 5% dose decreased by 0%, the 10% dose by 9.98%, and the 15% dose by 16.19%. So it can be concluded that the highest decrease in TSS levels in using Ecoenzyme seen from the dose and residence time is at a dose of 15% on the 20th day of 16.19%, while the lowest decrease in TSS levels occurred in the treatment with a dose of 5% at 0%.

Discussion

The measurement data of COD parameters in tofu liquid waste shown in Table 5.1 shows a decrease in COD values in the test samples. The sample with the addition of a 15% dose of eco-enzyme on the 20th day succeeded in reducing the COD value by 288 mg/L in the tofu liquid waste so that it was below the applicable quality standards in PerMen LH No.5 of 2014.

Based on this research, Eco enzyme is used to reduce chemical parameters, namely COD in tofu liquid waste with basic ingredients namely from molasses and fruit peels fermented for 3 months. The Eco enzyme used is at a dose of 5%, 10%, and 15% which is added to a 1 L wastewater sample. At the time of sampling the room temperature was at 30 ℃ and sampling at 10:30 WIB on June 4, 2024. The temperature used in the storage of this sample is 4℃ because so that the wastewater and ecoenzyme are not damaged, the sample storage is placed at a cool temperature.

The longer the eco-enzyme was left with the wastewater, the higher the COD reduction. The number of eco-enzyme concentrations added ranging from 9% to 13% to the sample also showed a decrease. The highest decrease in COD levels occurred in the sample with the addition of 27% eco-enzyme on day 5, which was 100%. While on the 5th day at 9% and 13% concentrations respectively had the ability to reduce by 70% and 93% (Putri, 2024).

In another study, it was shown that the residence time and eco enzyme levels influenced the COD reduction. The longer the residence time from 10 to 20 days, the higher the COD reduction. The more eco enzyme content added from 10% to 20%, the smaller the COD reduction. The highest COD reduction of 77.45% occurred in the addition of 10% eco enzyme with a residence time of 20 days. The lowest COD reduction of 2.05% occurred in the addition of 20% eco enzyme with a residence time of 10 days (Widyastuti et al., 2023).

The measurement data of the TSS parameter in the tofu liquid waste that has been displayed in Table 5.1 shows a decrease in the TSS value in the test sample. The sample with the addition of a 15% dose of ecoenzyme on the 20th day succeeded in reducing the TSS value by 176 in the tofu liquid waste so that it was below the applicable quality standards in PerMen LH No.5 of 2014.

Sato's research, 2015 stated that the test sample with the addition of ecoenzyme with a percentage of 10% better reduced the TSS value than ecoenzyme with a concentration of 5%. The decrease in TSS levels during processing can occur due to the reaction of bacterial precipitation with waste where the coagulation process occurs slowly and the smallest particles in the waste will go down and will become sediment (Ramadhana, 2023).

This is likely because the concentration of Eco enzymes given during dilution was too much, causing the sample to become cloudy and the Eco enzymes did not work optimally. The decrease in TSS parameters is also directly proportional to the pH value. pH that is close to acidic will provide a better reduction in TSS levels than pH that is close to alkaline. In this case, it can be seen that the pH when the research was carried out getting pH 5 showed the value closest to acid than the pH value so the TSS value in tofu wastewater can decrease under anaerobic conditions but the decrease is not large (Ardiansyah and Mirwan, 2024).

In the research of Sains et al. (2022), samples with the addition of eco enzymes succeeded in reducing the TSS value in tempeh liquid waste to below the applicable quality standards in PERMENLH No.5 of 2014. The decrease in TSS value in this tempeh liquid waste study is in line with the results of research conducted by Rasit & Kuan (2015) on palm oil liquid waste which, with the addition of eco-enzymes, succeeded in reducing the TSS value by 30%-50% of the initial value. Another study using eco-enzymes showed similar results in the form of a decrease in TSS value with a percentage decrease in TSS value of 68.43% (Arun & Sivashanmugam, 2015).

Eco enzyme used to reduce TSS parameters in tofu liquid waste with basic ingredients namely from molasses and fruit peels fermented for 3 months. In this study, the eco enzyme used is at a dose of 5%, 10%, and 15% which is added to a 1 L wastewater sample. At the time of sampling the room temperature was at 30 ℃ and sampling at 10:30 WIB on June 4, 2024. The temperature used in the storage of this sample is 4℃ because so that the wastewater and ecoenzyme are not damaged, the sample storage is placed at a cool temperature.

CONCLUSION

In the research conducted by researchers knowing the effect the effectiveness of Ecoenzyme in reducing COD and TSS parameters, it can be concluded that there is a decrease in COD and TSS levels in Tofu Industry liquid waste using Ecoenzyme with doses of 5%, 10% and 15% in detention time on the 10th, 15th and 20th days. The statistical test results show, that the longer the time and the higher the dose, the higher the effectiveness of reducing chemical parameters using Eco Enzyme. The test results show the significance value of COD and TSS 0.000 <0.05, so there is an influence on the decrease in COD and TSS levels in tofu liquid waste. It can be concluded that the most drastic decrease in the dose of 15% ecoenzyme with a detention time of the 20th day to get a COD value of 288 mg/L and TSS 176 mg/L so that this value meets the quality standards in accordance with PERMEN LH No.05 of 2014 concerning Soybean Processing, therefore if the waste that has met the quality standards is safe to be discharged into the environment.

Suggestion

Further research needs to be done related to the addition of ecoenzym dosage and detention time in reducing the chemical parameters of tofu liquid waste.

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