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THE CHARACTERIZATION OF GUAVA ECO ENZYME AND ITS CORRELATIONS TO NH_3, PO_4, AND pH REDUCTION IN WATER SAMPLES

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Abstract. Production of organic waste that is dominating waste generation becomes a problem for the environment. Eco enzyme is a solution made from brown sugar, water, and fermented fruit waste. Eco enzyme can become one of solution to reduce waste generation. Eco enzyme utilize organic waste recycling and brown sugar as the fermentor. This solution can be utilized into multipurpose cleaning liquids, eco enzyme also can reduce the wastewater contaminant, it can reduce effect of wastewater after dispose to the environment. This research has purpose on determines the characteristic of the guava eco enzyme and the correlation on the reduction of NH_3, pH, and PO_4 in water. The research results show that the guava eco enzyme is acidic with pH 3.36, it also containing 1.4 ppm of NH_3, 11.2 ppm of PO_4, and 116800 mg/l of COD. From the observation in the variation of time eco enzyme can reduce NH_3 and PO_4 also pH value. With 2% of guava eco enzyme concentration, it can reduce 27.5 % of NH_3 with eight hours observation and 20% of PO_4 contaminant in the water in 6 hours observation. From the analysis of guava eco enzyme, resulted that a higher concentration of an guava eco enzyme can reduce higher contaminant. With higher concentration of eco enzyme which 5%, 7%, and 10% it can reduce 28.3%, 30.1%, and 31% of NH_3. From correlation analysis there is strong correlations between NH_3 and pH reduction percentages with a concentration of eco enzyme added to the water. A small amount of guava eco enzyme also effective in reducing the pH of the water. It can reduce until 50% of pH by 2.4% eco enzyme concentration. This finding may contribute as the baseline for further improvement of household wastewater pre-treatment.

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1 Introduction

Waste cannot be separated from daily human life, as waste is the substances disposed of intently by the human and by-product of daily human activity [*1*]. The rapid growth of the population in Indonesia affected the raising of waste generated every year. Data collected that every single person in Indonesia produced around 0.8 kg/capita/day of waste [2]. Indonesia generated around 35 million tons of waste in 2020, which projected will be increased every year. This condition has lead to a higher cost of waste management. Waste generation in Indonesia is dominating by 30.8% of food waste [3]. By the domination of food waste production, food waste is categorized as organic waste as it contains various organic matter, which generates methane and carbon dioxide.

Waste management becomes the country's challenge that still struggles to find the proper method of waste management. From the overall waste generation, only 54.25% of waste is well managed to the open dumping as standard disposal method in Indonesia [2]. Improper waste management will cause several environmental issues as the raising of greenhouse gases, land pollution, water pollution, and air pollution [4]. Reduce, reuse, and recycle become the principle of waste management that can be implemented to handle waste generation before disposal to the landfill.

A waste recycling alternative that can be implemented to reduce solid waste generation, especially food waste, is the fermentation of organic waste become eco enzyme. This method converts organic waste and organic materials from fruits and vegetable into valuable enzymes by the fermentation process. The eco enzyme or garbage enzyme can be applied to multi-function and multipurpose cleaners.

As the raising of human population solid waste is not the only problem, sewage transfer and current waste administration become important. The wastewater that disposes directly to the environment can cause an environmental issue that harms the environment. This issue can contaminate the quality of

surface water and affect the health problem for those using the water as waste waster has several contaminants. This condition should be tackle with pre-treatment of wastewater before disposal. The use of eco enzyme can become one of the options to reduce the contaminant in the wastewater. Eco enzyme can act as a disinfectant to clean the house, insecticide, and cleaning liquids [5].

For the eco enzyme to reduce the contaminant in the water, several tests need to be held to know the reduction of contaminant by eco enzyme. Guava *(Psidium guajava)* is used as the eco enzyme material that will be tested to observe the effect of the eco enzyme in reducing the contaminant.

This research will concentrate about identify the character of guava eco enzyme, identify the contaminant reduction, and find the correlation between concentration added in the water with contaminant percentage reduction. The parameter that will be observed are pH, NH_3, PO_4, and COD.

2 Method

2.1 Population and Sample

The location of this research takes place at President University Environmental engineering laboratory. The population of this research is water that is artificially contaminated water used to be treated using eco enzymes. Water will be contaminated with NH_3, PO_4, and pH increasing. The sampling method for this research is the random sampling method in which the sample is taken randomly.

2.2 Material

Guava eco enzyme solution were prepared for this research. The eco enzyme is made from fermentation of guava, brown sugar, and water. Guava that has been cut was mixed with brown sugar and water with ratio 3:1:10. The mixture was mixed at air tight plastic container and fermented for 6 months. The gas that is produced along the process is released to avoid rupturing[6].

2.3 Data Collection

This reaserch is conducted in laboratory scale to collect the data. This research using primary data as the data needed. The primary data is obtained from experiment and laboratory observation.

The observation for this research using different eco enzyme concentration added to the population, the sample is measured every hour until there is significant reduction of the contaminant. It also to identify the reduction of the contaminant concentration.

2.3.1 PO_4 and NH_3 Concentration

Phosphate water contaminant is measured using spectrophotometer with commercial reagent that has been calibrated and fulfilled the acceptance criteria. The sample is mixed with each reagent, the mixture is analyse using spectrophotometer to generate the absorption value and find the concentration of the contaminant.

2.3.2 pH

pH 10 of water is measured using SNI 06-6989.11-2004 method to measure water pH. Measurement using calibrated Instrument digital pH, pH 7 and pH 4 buffer used as calibration solution. The measurement done by dipping the conductor at homogenous water until the value is steady.

2.3.3 COD

The method of measurement using the close reflux method, which oxidizing the organic matter by boiling a mixture of chromic and sulfuric acids. For the procedure, mix 25 ml of sample with 3.5 ml sulfuric acid and 1.5 ml $K_2Cr_2O_7$ in the digestion tube. After that, place the sample at the thermoreactor for 2 hours at 150° C. Cool down the sample and pour the sample at beaker glass with 5 ml aquadest. Add 2 drops of ferroin indicator, then titrate the sample with FAS solution until the color change from blue-green to reddish-brown.

For analyzing the COD content using formula

$$COD\ as\ mg\ O_2/L = \frac{(A-B)xMx8000}{ml\ sample} xf \quad [1]$$

Where:

A = ml FAS used for blank
B = ml FAS used for sample
M = molarity of FAS for sample
8000 = milliequivalent weight of oxygen x 1000 ml/L
f = dilution factor

2.4 Data Analysis

Data analysis is used to validate the data that has been collected using statistical analysis.

2.4.1 T-Test

T-test is an inferential statistic used to decide whether there is a significance difference between two paired samples. This test also a hypothesis checking technique that can test an inference that applies to a population. The test using Microsoft excel 2013 to test the data. The hypothesis applied is Ho the mean of the paired differences is not different with zero and Ha the mean of paired differences is different from zero.

Ho: $\mu_D = 0$
Ha: $\mu_D \neq 0$

T-test that is used is paired two samples for means t-test, which shows the significance of the result from the initial water condition. T-test is applied to prove the effect of eco enzyme to pH, NH_3, and PO_4 reduction. From this test, if the p-value less than 0.05, Ho is rejected

2.4.2 Correlation analysis

Correlation analysis is used to test the correlation between two variable and show how strong the correlation between the variable. The correlation is define by the correlation coefficient. Score from +0.5 to +1 means strong correlation, -05 to -1 is strong negative correlation and if 0 is no correlation. Correlation analysis will be applied to identified the correlation between concentration of eco enzyme with percentage of contaminant reduction.

3 Results and Discussion

The research about wastewater purification using guava eco enzymes was done in the laboratory. This research uses eco enzymes as the purifier of artificial wastewater. The eco enzyme is also personalized; the sample is observed before and after purification using the eco enzyme.

3.1 Eco Enzyme Characteristic

The initial measurement of the eco enzyme is found in the below table.

Table 1. Eco enzyme characteristic result

No	Parameter	Result	Units
1	COD	116800	mg/L
2	pH	3.36	-
3	NH_3	1.4	Ppm
4	PO_4	11.2	Ppm

From the observation, guava eco enzymes have 116800 mg/l of COD

concentration, the finding different from COD concentration on other research. Compare to the COD concentration of tomato eco enzyme 80,000 mg/l and orange eco enzyme 96,000 mg/l, COD concentration at guava is higher [7]. The Guava eco enzyme has acidic characteristics with a pH of 3.36; the pH of the guava eco enzyme is not significantly different with tomato eco enzyme pH 2.79 and orange eco enzyme 2.86 [7].

Acidic characteristic at eco enzyme because the presence of acetic acid inside the eco enzyme is also the result of the fermentation process of the eco enzyme [8]. The amount of ammonia is 1.4 ppm, which is considered low based on the Ministry of Environmental and Forest Regulation No. 68 the Year 2016 about domestic wastewater standard. As the previous research does not mention the value of ammonia.

3.2 NH_3

Ammonia reduction observations were made for 8 hours with 2% of eco enzyme concentration and resulted from a total reduction of 28.7%.

Table 2. Reduction of NH_3 with 2% eco enzyme

T	Concentration(ppm)	Reduction %
0	17.7	0
1	16.2	8.7%
2	17.0	4.3%
3	15.9	10.5%
4	16.5	7.0%
5	14.7	17.3%
6	15.1	15.0%
7	16.1	9.1%
8	12.8	27.5%

For reduction of contaminant is analyse using t-test, the result is significant, with a two tail p-value is 0.003; the null hypothesis is rejected. The result also means there is a significant difference of the result with an expected value. P-value is <0.05; this condition becomes the requirement of null hypothesis is rejected [9].

The observation is continued using different eco enzyme concentration which 5%, 7%, and 10% to identify the correlation of different concentration.

Table 3. Percentage of reduction for 2%, 5%, 7%, and 10% concentration

NH_3	Dose			
	2%	**5%**	**7%**	**10%**
T0 ppm	17,7	15,6	16,3	14,9
T8 ppm	12,8	11,2	11,4	10,3
% Reduction	27,5	28,3	30,1	31,0

From the observation and measurement of ammonia reduction from several concentrations, it was found that the higher concentration of eco enzyme resulted higher percentage of reduction. From the correlation analysis, the correlation coefficient is 0.97 which near to one, means there is a strong corelation between concentration of eco enzyme added with percentage of NH_3 reduction. The increasing of eco enzyme concentration happened together with ammonia reduction.

Table 4. Correlation analysis of Eco Enzyme Concentration with Percentage of NH_3 Reduction

	Dose	**%reduction**
Dose	1	
%reduction	0.9707696447	1

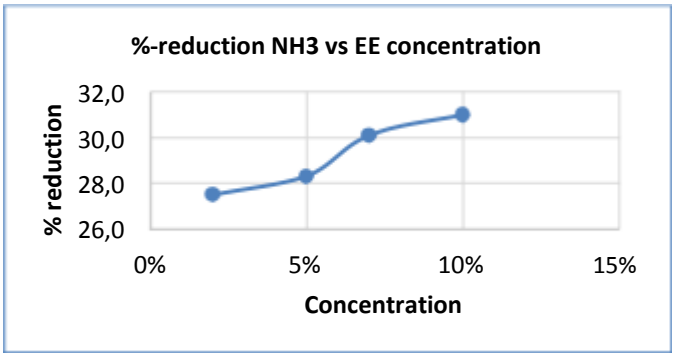

Fig. 1. Reduction percentage vs. eco enzyme concentration

3.3 PO_4

The result of 6 hours reduction with every hour observation is 20%. The reduction relatively same continued with 20 hours observation. Previous research of phosphorus reduction with orange eco enzyme was 99 % with 10% of concentration and 10 days treatment [7].

Table 5. PO_4 reduction in 20 hours

T (hour)	Concentration (ppm)	% reduction
0	12,0	0%
1	10,6	12%
2	8,5	29%
3	9,3	23%
4	9,1	24%
5	7,9	34%
6	9,7	20%
20	9,9	18%

The reduction of phosphate is significant based on t-test analysis with p-value is 0.001. The result of p-value is <0.05 means null hypothesis is rejected which the difference between initial PO_4 concentration with eco enzyme added concentration is statistically significant during 20 hours of observation.

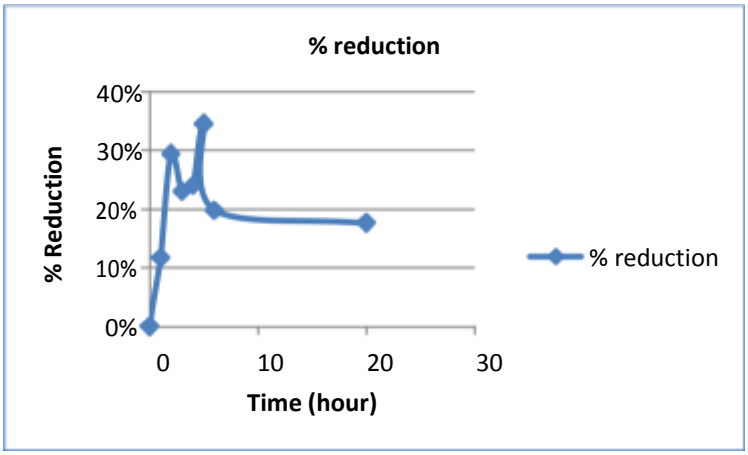

Fig. 2. Reduction of PO_4 in 20 hours

3.4 pH

The observation time of pH reduction takes around 3 hours to reach stable pH. For the observation it divides into several dilutions of eco enzymes which, 0.10%, 0.2%, 0.4%, 0.8%, 1.2%, 1.6%, and 2.4%.

Table 6. Reduction of pH in 3 hours with different eco enzyme concentration

Time	Eco Enzyme Concentration						
	0,25 ml	**0,5 ml**	**1 ml**	**2 ml**	**3 ml**	**4 ml**	**6 ml**
	0,10%	**0,20%**	**0,40%**	**0,80%**	**1,20%**	**1,6%**	**2,40%**
30	10,48	10,61	10,70	10,54	10,25	10,33	10,33
60	10,44	10,51	10,49	9,96	7,51	5,46	4,46
90	10,41	10,49	10,46	9,87	7,11	5,44	4,45
120	10,37	10,46	10,44	9,77	6,41	5,34	4,38
150	10,35	10,45	10,40	9,74	6,77	5,86	4,40
180	10,34	10,42	10,39	9,66	6,69	5,36	4,39

The result of 3 hours observation there is a different result from different eco enzyme concentrations. The purpose is to reach the standard effluent of wastewater based on the national regulation requirement. The proper concentration of eco enzyme to reduce pH 10 water was 1.2%, it reduce the water pH to pH 6.69. This concentration remain as optimum because it can comply wastewater national standard effluent No. 68 year 2016 with the range value pH 6-9.

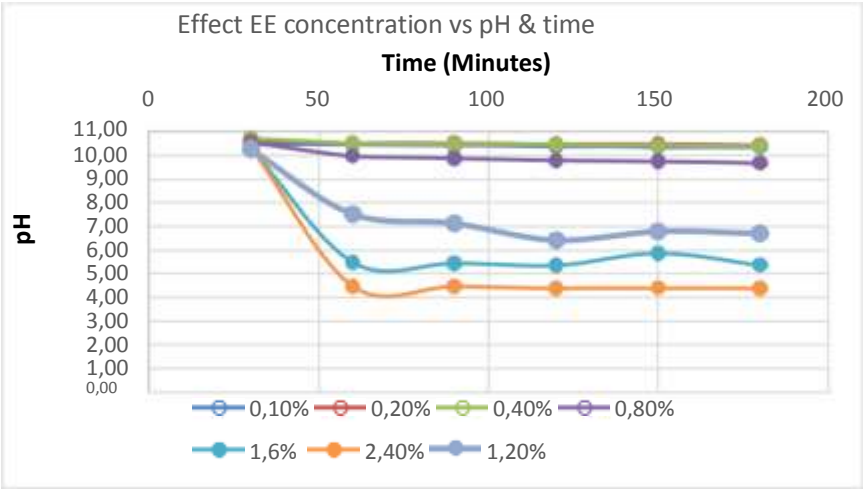

Fig. 3. Reduction of pH in 3 Hours With Different Eco Enzyme Concentration

To prove the effect of the eco enzyme to the water pH, t-test analysis is held to the lowest concentration of eco enzyme added. The result of the test is two tail p-value is 0.01 therefore, null hypothesis is rejected. The difference between initial pH with added eco enzyme pH is statistically significant.

Table 7. T-test result

df	P-Value	t crit
5	0.0148	2.57

Different concentrations also give a different percentage of reduction, which is higher concentration also higher reduction percentage. The reduction of pH in wastewater is caused by acetic acid and lactic acid in eco enzyme [10]. The acidic characteristic of the eco enzyme makes the dilution reduce the pH value.

Table 8. Reduction Percentage of every dose

Dose	%reduction
0,10%	1,34
0,20%	1,79
0,40%	2,90
0,80%	8,35
1,20%	34,73
1,60%	48,11
2,40%	57,50

From the analysis of correlation, the result of correlation coefficient is 0.96 that near to 1. The result means a there is strong correlation between the concentration of eco enzyme added with the percentage of pH reduction. It also means there is linear correlation between eco enzyme concentration with pH percentage reduction, the increasing of eco enzyme concentration happened together with increasing with percentage of pH reduction.

Table 9. Correlation analysis of Eco Enzyme Concentration with pH Reduction Percentage

	Dose	%reduction
Dose	1	
%reduction	0.965788941	1

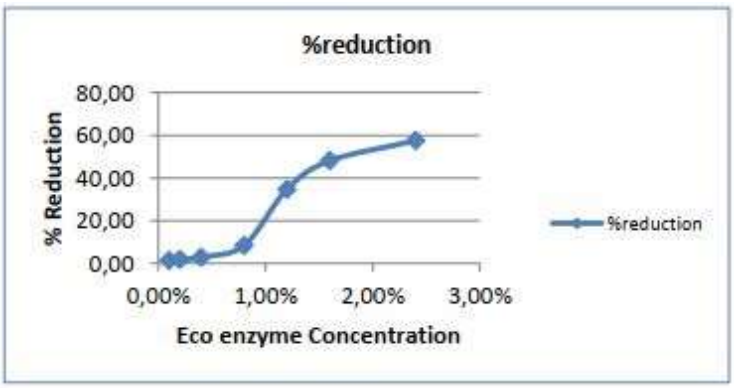

Fig. 4. Reduction Percentage of every dose

4 Conclusions

1. The characteristic of the guava eco enzyme is acidic with pH 3.36. Guava eco enzyme has 1.4 ppm of NH_3, 11.2 ppm of PO_4, and high COD, 116800 mg/l.
2. Guava eco enzyme can reduce water pH until 57.5%, with 2.4% of eco enzyme concentration. The optimum concentration of guava eco enzyme to reduce pH 10 water is 1.2% to fulfill the standard effluent of wastewater.
3. Guava eco enzyme can reduce NH_3 in water until 31% with 10% of eco enzyme concentration in 8 hours observation. In 6 hours observation, it also reduces 20% of PO_4 in water with 2% of eco enzyme concentration.
4. There is strong correlation between eco enzyme concentration added with percentage of pH and ammonia reduction. The increasing of concentration of guava eco enzyme happened together with increasing of percentage of pH and ammonia.

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