Utilization of Eco Enzyme for Wastewater Treatment (Greywater) at Kuningan University

Nurdin Nurdin[1], Dede Kosasih[2], Ika Karyaningsih[3], Age Mulyanto[4], Haydar Rahardian[5]

Universitas Kuningan, Kuningan, Indonesia

{[1]nurdin@uniku.ac.id, [2]dede.kosasih@uniku.ac.id, [3]ika.karyaningsih@uniku.ac.id, [4]mulyantoega555@gmail.com,[5]haydarrahardian1@gmail.com}

Abstract. Greywater in Kuningan University comes from bathing, hand washing and washing utensils. The waste is discarded into the environment without going through the treatment stage so that it has the potential to pollute the environment. In this study, we used an environmentally friendly and cost-effective biological treatment method. This method uses eco-enzyme derived from a mixture of brown sugar, pineapple and water in a ratio of 1:3:10 which is fermented for 90 days. The purpose of this study is to determine the characteristics of greywater before and after being treated using eco-enzyme with a concentration of 10% for 5 and 15 days. Results obtained show that the eco enzyme is effective in aerobic conditions with a duration of 15 days after it's being confirmed in the Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number: P.68/Menlhk/Setjen/Kum.1/8/2016 concerning domestic waste quality standards. Further research is needed to find a more appropriate dose of eco enzyme so that the BOD and COD content of greywater which discarded into the environment meets environmental standards.

Keywords: Greywater; eco enzyme; pineapple; kuningan university.

1 Introduction

Along with the increasing number of people who inhabit a certain place with all their activities, a number of wastewater will also be generated. If it isn't managed properly, the wastewater will become a serious problem. Wastewater can come from household, industrial or other public places that contain materials which can endanger human life and living things that can interfere the environmental sustainability [1]. The wastewater which comes from businesses and residential activities (real estate), restaurants, offices, commerce, apartments and dormitories is called as domestic wastewater [2]. Greywater is wastewater that comes from bathing and washing activities [3]. Water pollution that occurs is a result of the absence of an adequate wastewater treatment system.

Greywater that is produced every day in Kuningan Unuversity is directly discarded into the drainage without prior treatment. It can affect on decreasing the quality of downstream waters and causing a stink aroma. Environmentally friendly waste treatment has been implemented through the "Green Campus" policy in Kuningan University with the Reduce, Reuse, Recycle (3R) program in accordance with the criteria that set by UIGreenmetric [5]. Environmentally friendly and sustainable treatment is needed to organize the greywater in Kuningan University environment, it is by producing Eco Enzyme. Eco enzyme is a complex solution produced by

UNISET 2021, December 02, Kuningan, Indonesia

DOI 10.4108/eai.2-12-2021.2320222

fermenting fresh kitchen waste, sugar (brown sugar or molasses) and water. The color is dark brown and has a strong sweet and sour aroma of fermentation for household needs, agriculture, farm, gardening and others [6].

Eco enzyme is a solution of complex organic substances which produced from the fermentation process of organic waste, sugar, and water. The color of Eco enzyme liquid is dark brown and has a strong sour/fresh aroma [7]. When the fermentation process is completed, the eco-enzyme (dark brown liquid) will be formed and used for disinfecting house floors, baths, insecticides and sewer cleaning fluids [8]. Based on the problem of greywater waste in Kuningan University which is discarded into the environment without going through a treatment process, it is necessary to immediately conduct research on waste treatment using eco-enzyme, a liquid made from environmentally friendly raw materials.

2 Methodology

The research was carried out in Kuningan University from April to August 2021. The testing of the characteristics of greywater before and after being treated with eco-enzyme was carried out at the Sucopindo Cirebon Laboratory. The Greywater as a research material was taken from the waterways outlet of each bathroom and kitchen. The raw materials for making eco enzymes are pineapple and brown sugar which obtained from traders around the campus and the water is obtained from a well in Kuningan University. The tools used consist of jars with threaded lids, organic material chopping knives, chopping mats, plastic buckets, balance sheet and writing utensils. Measuring equipment for greywater characteristics before entering the laboratory consists of a thermometer, water pH meter, TDS meter.

Figure 1. Research Location

Primary and secondary data collection and analysis are presented in Figure 2 below:

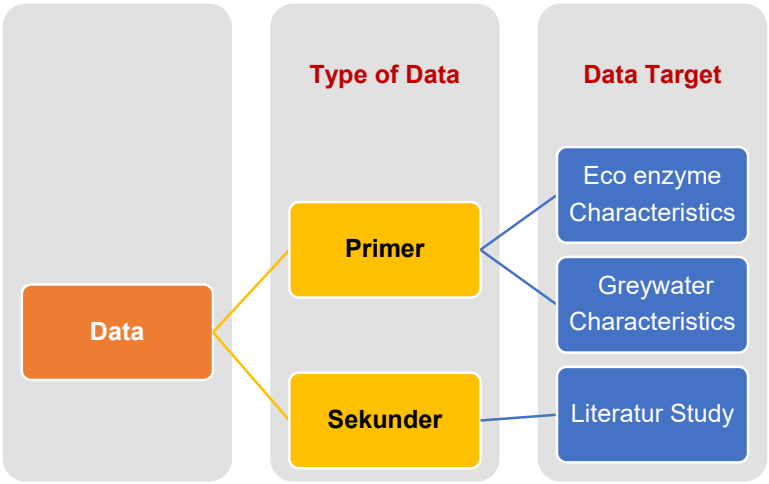

Figure 2. Kinds of Research Data

Eco enzyme is made through a three-month fermentation process. The raw materials for eco enzyme are brown sugar, organic waste and water, with a ratio of brown sugar (1 part), organic materials (3 parts) and water (10 parts). Organic waste utilizes fresh fruit and vegetable waste collected from the campus canteen and campus activities that provide banquet facilities in the form of fruits. The next ingredient is brown sugar that obtained from the society around the campus and the water is obtained from a well. The stages of making eco enzyme are presented in Figure 3 below.

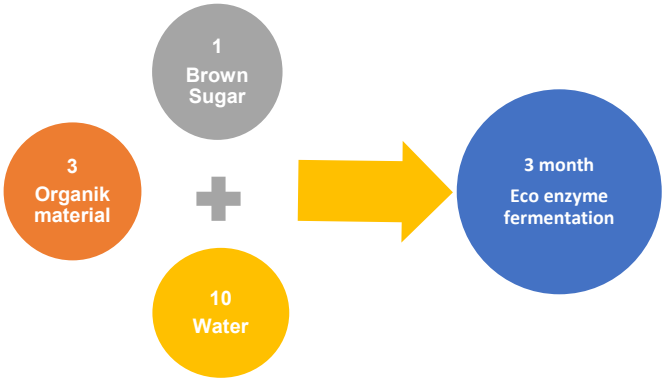

Figure 3. Manufacturing Stages of Eco-Enzyme

Sampling of the greywater of the outlets uses the composite place sample method in accordance with SNI 6989.59:2008 concerning the method of taking wastewater samples. Greywater samples which obtained from the outlets at Kuningan University were composited using the Composite Place Sample method as shown in Figure 4a. The results of internal data analysis are recorded on a tally sheet as analysis material as shown in Figure 4b. Samples to be tested externally are taken and put in a special container [10]. Sample testing uses eco enzyme that is made from pineapple which has a low pH [11].

Greywater sample testing was carried out at Sucofindo Laboratory Cirebon with two activity stages. The first stage of sample testing was carried out before it's being given of eco-enzyme treatment and testing was carried out after the sample was given of eco-enzyme in the second stage. The second stage of sample testing was carried out after 5 days and 15 days [8] with an addition of a concentration of 10% eco enzyme [12]:

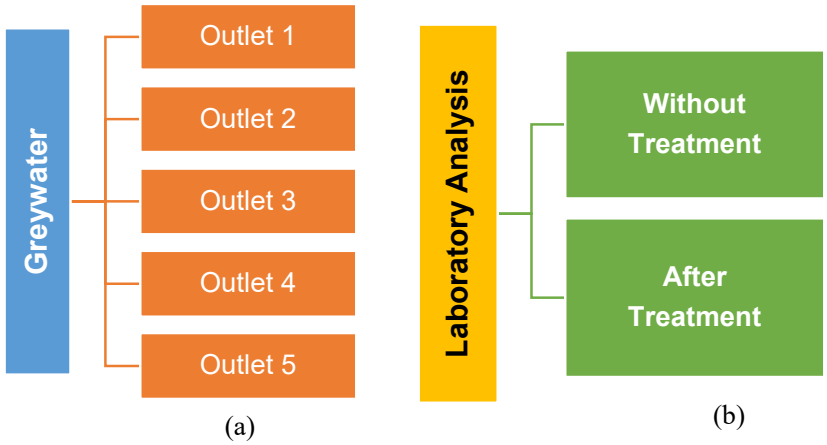

Figure 4. Sampling Stages (a) and Greywater Characterictic Analysis (b)

3 Result and Discusion

3.1. Eco Enzyme Characteristics

The raw materials consist of skin and flesh of pineapple, brown sugar and water. Raw materials were put into airtight plastic jars with a ratio of 1:3:10 (1 part sugar, 3 parts fruit/vegetables, 10 parts water) (Neupane, K. And Khadka, R. 2019) [13]. These materials were fermented for 90 days and stored in a cool place and not exposed to sunlight [14]. The stages of making eco enzyme are presented in Figure 5.

(a) (b) (c) (d)

Figure 5: Manufacturing Stages of Eco Enzyme: (a) Organic Materials, (b) Water and Sugar, (c) Fermentation, (d) Fermentation Result

After the fermentation period is completed, eco-enzyme liquid will be obtained with a fresh sour aroma such as vinegar [15] which has a dark brown color indicating that the eco-enzyme has been completely fermented [16]. The results of measurements of pH, TDS and pineapple eco enzyme aroma are presented in table 1 below;

Table 1: characteristics of Pineapple Eco Enzyme

Repetition	pH	TDS (mg/l)	Volume (liter)	Aroma
1	3,10	1840	2,8	Fresh sour
2	3,20	1980	2,8	Fresh sour
3	3,10	1890	2,85	Fresh sour
4	3,10	2070	2,87	Fresh sour
5	3,10	2000	2,55	Fresh sour
Average	**3,12**	**1956**	**2,774**	**Fresh sour**

The test results of a low pH below 3.5 indicate the character of fresh sour. The low pH value of eco-enzyme is a result of the high content of various organic acids [17, 18]. The higher the organic acid content such as acetic acid or citric acid, the lower the pH value [19].

3.2. Greywater Sample Characteristics

Greywater used in this research is waste that collected from each outlet in Kuningan University (Figure 6). Samples were collected in buckets and then put in clean plastic jerry cans to be analyzed at the Sucofindo Cirebon Laboratory.

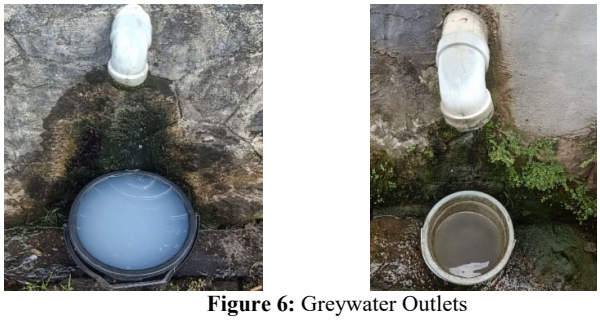

Figure 6: Greywater Outlets

The analysis includes physical, chemical and biological parameters which refer to the Minister of Environment and Forestry Regulation number 68 of 2016 concerning domestic waste quality standards. The results of the analysis are presented in table 2 below:

Table 2: Greywater before being given a treatment

Parameter	Unit	Test Results	Environmental Quality Standard	Methods •) Part Number
pH at lab ●	-	6.71	6 – 9	4500-H^+-B
BOD 5 days 20 °C	mg/L	49.4	30	5210 B
COD by $K_2Cr_2O_7$ ●	mg/L	141	100	PO/CBN-
Total Suspended Solid ●	mg/L	28.3	30	2540 D
Oil & Grease ●	mg/L	< 4	5	5520 B
Ammoniac ●	mg/L	7.8	10	4500-NH_3-F
Total Coliform ●	colony/100 mL	2900	3000	9222 B

The results of the analysis of pH, TSS, oil & grease, ammonia and total coliform were under the environmental quality standards. However, BOD and COD are still above the quality standard, it means that it still requires a treatment. The low TSS value is due to infrequent or no bathing and washing activities [20]. Such conditions are also possible due to limited activities in the use of bathrooms and washing areas. Wastewater which only includes waste water from sinks, washrooms and bathrooms and others that are not too dangerous to be discarded of [11].

3.3. Greywater Sample Characteristics after Being Treated for 5 Days

The results of Greywater after being treated with 10% eco-enzyme for 5 days in an airtight jerry can are presented in table 3 below:

Table 3: Greywater after being treated

Parameter	Unit	Test Results	Environmental Quality Standard	Methods •) Part Number
pH at lab ●	-	3.80	6 – 9	4500-H^+-B
BOD 5 days 20 °C	mg/L	1904	30	5210 B
COD by $K_2Cr_2O_7$ ●	mg/L	5440	100	PO/CBN-
Total Suspended Solid ●	mg/L	381	30	2540 D
Oil & Grease ●	mg/L	210	5	5520 B
Ammoniac ●	mg/L	4.43	10	4500-NH_3-F
Total Coliform ●	colony/100 mL	18000	3000	9222 B

The results of the analysis of physical, chemical and biological parameters show the values above the environmental quality standards. The high value of COD results in low dissolved oxygen content and an increase in BOD value [21]. This condition is caused by the treatment carried out under anaerobic conditions and microorganisms cannot function in environmental conditions with pH> 9.5 and < 4 and even die [22]. Beside that, the existing enzyme

substances produced with organic materials of fruit waste or organic solid waste and molasses added as a substrate in the anaerobic process triggers the high TDS of eco-enzyme [23]. The addition of eco-enzyme which is strongly acidic in the sample results a decrease in the pH value [24].

3.4. Greywater Sample Characteristics after Being Treated for 15 days

The results of Greywater after being treated with 10% eco-enzyme for 15 days in an open container are presented in table 4 below:

Table 4: Greywater after being treated

Parameter	Unit	Test Results
pH	-	8,2
TDS	mg/L	1030
Aroma	mg/L	Tidak beraroma

The measurement results show that the pH value and aroma parameters of the waste have met environmental standards. This is possible because the work process of bacteria and enzymes under aerobic conditions is more optimal. Aerobic bacteria will work more optimally if their oxygen needs are met so that the rate of decomposition of pollutants is more effective [25]. However, TDS still requires further treatment even though the value is better than the 5-days treatment in an airtight container (2190 mg/L). The high TDS value is due to the accumulation of organic material substrates and sugar/molasses in the fermentation process [16].

4 Conclusion

The results of the greywater analysis at Kuningan University have pH, BOD and COD content above the quality standard if it's confirmed by the Minister of Environment and Forestry Regulation number 68 of 2016 concerning domestic waste quality standards. Parameters TSS, Oil & Grease, ammonia and total coliform have met the quality standards, this is because the activities that cause the generation of these parameters are relatively more limited. Greywater that is discarded into the environment requires prior treatment so that it does not burden and pollute the environment.

Greywater treatment that is environmentally friendly and cost-effective is to use eco-enzyme made from pineapple. The eco-enzyme substances made from pineapple has a blackish brown color and a strong acid (pH 3.12) with a fresh distinctive aroma containing high dissolved organic materials. Greywater treatment using pineapple eco enzyme is effective in aerobic conditions with a duration of more than 5 days.

References

[1] APHA, AWW, WEF, Standard Methods for the examinations of water and wastewater, 2012, 22th edition.

[2] Leal Filho, Viktoria Voronova , Marija Kloga , Arminda Paço , Aprajita Minhas, Amanda Lange Salvia, Celia Dias Ferreira, Subarna Sivapalan.2021. COVID-19 and Waste Production In Households: A Trend Analysis Science Of The Total Environment. Science of the Total Environmen 777: 1-7.

[3] Bismark Dwumfour-Asare, Kwabena B.Nyarko, Helen M.K.Essandoh, Esi Awuah.2020. Domestic greywater flows and pollutant loads: A neighbourhood study within a university campus in Ghana.Scientifik Afrikan, 6:1-12.

[4] Suoth, A.E. , Nazir, E. 2016. Karakteristik Air Limbah Rumah Tangga (Grey Water) Pada Salah Satu Perumahan Menengah Keatas Yang Berada Di Tangerang Selatan. Ecolab. 10 (2): 47 – 102.

[5] Nasihin, I., Kosasih, D., Nurlaila, A. dan Alviani, Y.2019. Analisis Implementasi Kebijakan Green Campus. Prosiding.365-373.

[6] Nurdin, Nurlaila, A., Kosasih, D., Herlina, N. 2020. Asosiasi Vegetasi Terhadap Komunitas Burung di Kampus I Universitas Kuningan. Quagga:Jurnal Pendidikan Biologi, 12(2):145-155.

[7] Tang, Fu E. And Tong, C.W. 2011. A Study of the Garbage Enzyme's Effects in Domestic Wastewater. World Academy of Science, Engineering and Technology International Journal of Environmental and Ecological Engineering,5(12),887-892.

[8] Verma, Deepak , Singh, A.N, Sukla, A.K. See Of Garbage Enzyme For Treatment Of Waste Water ; Internasional Jurnal of Scinetifik Risearch and Review 7 (7):201-205.

[9] Rubin, M.B. (2001). The History of Ozone. The Schonbein Period, 1839- 1868. Bull. Hist. Chem. 26 (1) : 71-76.

[10] Badan Standarisasi Nasional. 2008. Metode Pengambilan Contoh Air Permukaan. SNI 6989.57.2008.

[11] Javalkar Sayali D., Shinde Shruti C., Savalkar Shweta S., Pawar Sudarshan E., Dhamdhere Akash H., & Patil Shrikant T.2019. Eco Enzymes in Domestic Waste Water Treatment. International Journal of Innovative Science and Research Technology.4(2):568-570.

[12] Kerkar, S.S. and Salvi S.S. 2020. Application of Eco-Enzyme for Domestic Waste Water Treatment. International Journal for Research in Engineering Application & Management (IJREAM); 05(11):114-116.

[13] Neupane and Khadka 2019. Production of Garbage Enzyme from Different Fruit and Vegetable Wastes and Evaluation of Its Enzymatic and Antimicrobial Efficacy. TUJM 6(1): 113-118.

[14] Vama, L. And Cherekar, M.N,.2020. Production, Extraction And Uses Of Eco-Enzyme Using Citrus FruitWaste: Wealth From Waste. Asian Jr. of Microbiol. Biotech. Env. Sc. 22 (2): 346-351

[15] Nazaitulshila Rasit, Lim Hwe Fern and Kuala Nerus. 2019. Production And Characterization Of Eco Enzyme Produced From Tomato And Orange Wastes And Its Influence On The Aquaculture Sludge. International Journal of Civil Engineering and Technology (IJCIET), 10 (03): 967-980.

[16] Rohmah, U.Nissa, Astuti, P.Andari dan Maharani, T.W., Endang.2020. Organoleptic Test Of The Ecoenzyme Pineapple Honey With Variations In Water Content.Edusaintek, 408-414.

[17] Arifin, L. W., Syambarkah, A., Purbasari, H. S., Ria, R. & Puspita, V. A. Introduction of eco-enzyme to support organic farming in Indonesia. Asian Journal of Food and AgroIndustry, 2009, 356-359.

[18] Etienne, A., Genard, M., Lobit, P., Mbeguie-Ambeguie, D. & Bugaud, C. What controls fleshy fruit acidity ? A review of malate and citrate accumulation in fruit cells. Journal of Experimental Botany, 64(6), 2013, 1451-1469.

[19] Etienne, A., Genard, M., Lobit, P., Mbeguie-Ambeguie, D. & Bugaud, C.(2013) What controls fleshy fruit acidity? A review of malate and citrate accumulation in fruit cells. Journal of Experimental Botany, 64(6), 1451-1469

[20] Natsir, M.F., Amaludin , Astisa Anggi Liani dan Anzakiyah Dwi Fahsa. 2021. Analisis Kualitas Bod, Cod, Dan Tss Limbah Cair Domestik (Grey Water) Pada Rumah Tangga Di Kabupaten Maros 2021. Jurnal Nasioal Ilmu Kesehatan(JNIK), 4(1),20-25.
[21] Natsir, M.F., Amaludin , Astisa Anggi Liani dan Anzakiyah Dwi Fahsa. 2021. Analisis Kualitas Bod, Cod, Dan Tss Limbah Cair Domestik (Grey Water) Pada Rumah Tangga Di Kabupaten Maros 2021. Jurnal Nasioal Ilmu Kesehatan(JNIK), 4(1),20-25.
[22] Jenie, B.S. dan Rahayu, W.P. 2007. Penanganan Limbah Industri Pangan, Penerbit Kanisius, Yogyakarta.
[23] Selvakumar, P. & Sivashanmugam, P.(2015). Optimization of lipase production from organic solid waste by anaerobic digestion and its application in biodiesel production. Fuel Processing Technology, 165, 2017, 1-8.
[24] Bharvi S. Patel 1, *, Bhanu R. Solanki 2 and Archana U. Mankad. 2021. Effect of eco-enzymes prepared from selected organic waste on domestic waste water treatment. World Journal of Advanced Research and Reviews, 10(01): 323–333.
[25] Jasmiati, Sofia, A., Thamrin. 2010. Bioremediasi Limbah Cair Industri Tahu Menggunakan Efektif Mikroorganisme (Em4). Jurnal Of environmental Sciense, 2(4):148-158.