Jurnal Presipitasi
Media Komunikasi dan Pengembangan Teknik Lingkungan
e-ISSN: 2550-0023

Vol 20, No 3, 2023, 665-668
Article available at homepage presipitasi

Original Research Article

Study of the Effect of Adding Eco-Enzyme to the Process of Decomposing Organic Waste on the Quality of Compost, Leachate, and Methane Gas Production

Anik Sarminingsih[1*], Sri Sumiyati[1], Syafrudin[1], Irfan Alfarisi[1], Risky Setiawan[1], Axelino Farrell Andika[1], Mustika Balqis[1]

[1]Department of Environmental Engineering, Faculty of Engineering Universitas Diponegoro, Semarang 50275, Indonesia
*Corresponding Author, email: aniksarminingsih@lecturer.undip.ac.id

Abstract

Waste generation is increasing along with the increase in population and human living needs. The most dominant waste composition in Indonesia is organic waste, which accounts for 53.97% of the total waste. Eco-enzyme is one of the waste utilization products that has the potential to become an activator for the decomposition process and reduce the environmental effects of waste decomposition. The aim of this research is to analyse the micronutrient content of compost, reduce leachate toxicity, and accelerate the production of methane gas resulting from decomposition using eco-enzymes. The method used was an experimental method (trial) to obtain primary data from laboratory test results during 28 days of research. The research results show that, in general, there is a significant difference in the quality of compost in organic waste that uses eco-enzyme compared to that that does not use eco-enzyme. The results of measuring the quality of the leachate resulting from decomposition show that the quality of the leachate that uses eco-enzyme is better and has lower toxicity than without using eco-enzyme (control). In the production of methane gas, the results show that methane gas production in decomposition using eco-enzymes reaches the methanogenesis process more quickly.

Keywords: Organic waste; eco-enzyme; compost; leachate; methane gas

1. Introduction

Indonesia is the country with the fourth-largest population in the world and will continue to increase every year. Garbage is one of the problems faced by the increasing population and human living needs. Based on SIPSN, in 2022, Indonesia will produce 35,110,804.83 tons of waste per year, or 96,193.99 tons per day, from various sectors of life. Based on composition, organic waste is the most abundant waste, with 53.97% of the total waste in the form of food scraps, twigs, and wood.

The increasing amount of waste causes the decomposition process to take longer and take up large areas of land for final processing. Organic waste, the most dominant waste composition, will produce compost after the decomposition process. The quality of the compost produced depends on the materials and treatment of the decomposed waste.

The environmental impacts resulting from the waste decomposition process are leachate and methane gas. Leachate is a liquid that seeps through piles of waste carrying dissolved or suspended material, especially the result of the decomposition process of waste material (Damanhuri, 2010). Leachate that seeps into the soil is able to directly pollute the soil and groundwater with organic and inorganic chemical compounds (Susanto, 2004). Apart from leachate, waste decomposition also produces methane gas. The degradation process of organic materials originating from waste will produce methane

gas (CH_4), CO_2, residual toxic materials, and odors. Methane gas and CO_2 gas are greenhouse gases that contribute to global warming (Park, 2011). In the aerobic process, CO_2 gas is produced with a shorter degradation time, but anaerobic degradation also produces CH_4 with a longer degradation time besides CO_2 gas (Tchobanoglous et al., 1993). According to the IPCC (2006), landfills in particular contribute between 3–4% of global greenhouse gas emissions to the waste sector's contribution to the atmosphere. Based on these problems, a solution is needed to reduce the negative impact of the decomposition process on the environment.

Eco-enzyme is a product of processing organic waste (such as vegetables and fruit pulp), molasses, and water. Nurfajriah et al. (2021) stated that eco-enzyme is a liquid extract that comes from the fermentation of fruit and vegetable residues to which brown sugar substrate is added. According to Muliarta et al. (2023), eco-enzyme has the potential to become an activator that can speed up the composting process. Apart from being a composting activator, eco-enzymes can also be used to degrade pollutants in waste water. According to Pratamadina (2022), in his research, the potential use of eco-enzymes in detergent degradation in domestic wastewater resulted in the conclusion that eco-enzymes could help reduce detergent concentrations in domestic wastewater by 5%–10% in 7 days. From these results, eco-enzyme also has the possibility of being used as a pollutant degrader in leachate produced from the waste decomposition process.

Based on the description of the many benefits of eco-enzymes, which are products of waste processing, there has been no previous research or study discussing the use of eco-enzymes as bioactivators in waste management. Specifically, the use of eco-enzymes has an impact on compost yields, leachate yields, and methane gas production. Based on this, research studies are needed regarding the effect of using eco-enzymes on the composting process, especially on the impact on compost quality, leachate quality, and methane gas production. This research will compare waste decomposition assisted by using eco-enzyme with several variations in concentration compared to using water alone. So, we will see the effect of using eco-enzymes on compost quality, leachate water quality, and methane gas production.

2. Methodology

2.1 Preparation Phase

The data in this study are primary data obtained from sample testing results in the laboratory. The method used in data collection was an experimental method (trial) to determine the effect of using eco-enzymes on compost quality, leachate quality, and methane gas production. The data required is the quality of the enzyme used. Then data on compost quality and leachate quality were compared with quality standards every 7 days for 28 days of research. Methane production data is measured every 3 days for 28 days.

The preparation stage for the eco-enzyme solution that will be used in the research is with three types of basic ingredients, namely orange-peel eco-enzyme, mixed fruit and vegetable eco-enzyme, and mixed fruit peel eco-enzyme. The enzyme used is a fermented product made by ourselves during three months of fermentation. The finished eco-enzyme product is characterized by a dark colour, a fresh smell like fermentation, and not being rotten or mouldy.

Figure 1. Eco-enzyme samples

2.2 Implementation and Monitoring Phase

The research was carried out using a reactor that was simply designed in such a way that it was able to monitor three control parameters directly. The reactor is made from used gallons and equipped with a methane gas hole at the top and a leachate hole at the bottom. A picture of the research reactor is in the following picture:

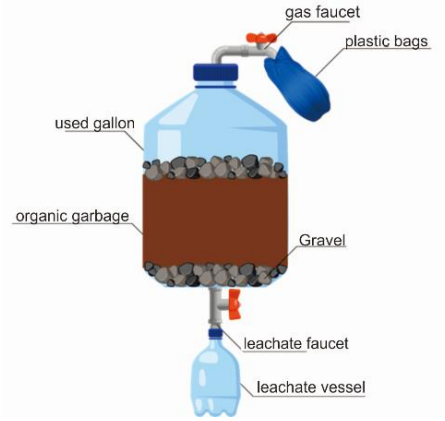

Figure 2. Research reactor

This research was carried out using an experimental plan for several treatments using eco-enzyme (EE). This treatment consists of:

Vo = organic waste height of 20 cm + 600 ml of water (control)
V1 =organic waste height of 20 cm + 600 ml of EE solution (1000x dilution of 1 ml EE with 1 liter of water)
V2 =organic waste height of 20 cm + 600 ml of EE solution (500x dilution of 2 ml EE with 1 liter of water)
V3 =organic waste height of 20 cm + 600 ml of EE solution (200x dilution of 5 ml EE with 1 liter of water)

From this treatment, parameters for compost quality, waste volume reduction, leachate quality, and methane gas production will be measured. The experimental plan table is in the following table.

Impact on composting performance																													
Material	**Treatment**	**C**				**N**				**P**				**K**				**pH**				**Moisture content**				**Decrease in Compost Volume**			
Time (Day)		7	14	21	28	7	14	21	28	7	14	21	28	7	14	21	28	7	14	21	28	7	14	21	28	7	14	21	28
organic garbage	K (0 ml)																												
	V1 (1 ml)																												
	V2 (2 ml)																												
	V3 (5 ml)																												

Impact on leachate quality and methane gas production																															
Material	**Treatment**	**COD**				**BOD**				**TSS**				**N**				**pH**				**CH4**									
Time (Day)		7	14	21	28	7	14	21	28	7	14	21	28	7	14	21	28	7	14	21	28	1	4	7	10	13	16	19	22	25	28	31
organic garbage	K (0 ml)																															
	V1 (1 ml)																															
	V2 (2 ml)																															
	V3 (5 ml)																															

Each parameter will be compared with regulations or quality standards, namely SNI 19-7030-2004 Specifications for compost from domestic organic waste and the leachate quality standards used, namely Minister of Environment and Forestry Regulation No. 59 of 2016 Leachate Quality Standards for Businesses and/or Activities at Waste Final Processing Sites. For methane gas, the reduction is only compared with the control to determine the most effective treatment.

3. Result and Discussion

3.1 Quality Eco-Enzyme Research

The enzyme that will be used for research consists of three types of ingredients: orange peel, mixed fruit peel, and mixed fruit and vegetable peel. The most effective type of enzyme will be selected based on the parameters C, N, P, and K by testing in the laboratory. The results of measuring the quality of eco-enzyme are in the following table:

Table 1. Quality of C, N, P, and K Eco-enzymes

Sample	Test Parameters	Unit	Results
Orange peel	C	ppm	401.44
	N	ppm	25
	P	ppm	4.89
	K	ppm	4.26
fruit skin + vegetables	C	ppm	648.31
	N	ppm	103.11
	P	ppm	6.43
	K	ppm	5.51
mixed fruit peel	C	ppm	764.56
	N	ppm	35.05
	P	ppm	6.86
	K	ppm	5.36

Based on the **table 1.** of eco-enzyme quality measurement results, parameters C and P are the highest for eco-enzyme made from fruit peel. The highest N and K parameters are in eco-enzymes made from mixed fruit and vegetable peels. Based on these results, to obtain maximum eco-enzyme quality results, it can be made using mixed fruit peels, which are predominantly mixed with vegetables. This is because the macronutrient content of the ingredients used is more complex than other ingredients, namely those found in the skin of fruit and vegetables, which are more dominant. In this research, eco-eznyme was used with mixed fruit and vegetable peels because it has a higher macronutrient quality than the others.

3.2 Effect of Eco-Enzyme on Compost Quality

The effect of eco-enzymes on compost quality takes into account macronutrient parameters, which are compared with compost quality standards. The compost quality standard used is SNI 19-7030-2004 concerning specifications for compost from domestic organic waste. The macronutrient parameters that are considered are C, N, P, and K, as well as physical parameters such as water content, pH, and waste reduction. The test results for each parameter obtained the following results.

3.2.1. Compost C (carbon) Measurement Results

The results of measuring the C (carbon) content of compost, which was measured once every 7 days during the 28 days of research, showed the following results.

Table 2. Compost C (carbon) measurement results

Test C	Vo (%)	V1 (%)	V2 (%)	V3 (%)	Quality standards
Week 1	36.09	15.31	10.7	13.67	9.80 % - 32 %
Week 2	17.27	25.45	13.52	16.87	
Week 3	6.15	7.51	7.297	7.815	
Week 4	5.57	5.65	4.042	5.634	

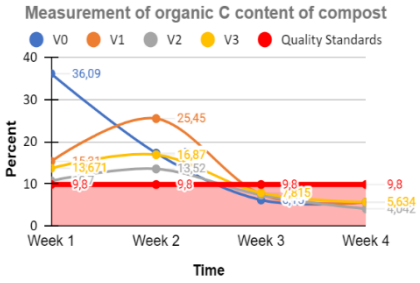

Figure 3. Carbon content in compost

Based on the results of measuring the quality of C (carbon) compost contained in **Table 2**, which is compared with the SNI quality standard of 9.80%–32%, it shows that the highest quality results close to the standard are V1, namely 5.65% with the use of eco-enzyme dilution 1000 times. The lowest C (carbon) result was v2, namely 4.042% with a 500x dilution. These results show that the use of eco-enzyme has a better impact on the carbon content of compost compared to the control without eco-enzyme.

3.2.2 Compost N (Nitrogen) Measurement Results

The results of measuring the nitrogen content of compost, which was measured once every 7 days during the 28 days of the study, showed the following results:

Table 3. Compost N (Nitrogen) measurement results

Test N	Vo (%)	V1 (%)	V2 (%)	V3 (%)	Quality standards
Week 1	5.359	1.808	1.334	1.423	0.4 %
Week 2	1.528	2.853	2.202	1.495	
Week 3	1.173	1.311	0.527	0.944	
Week 4	0.972	1.276	1.471	1.025	

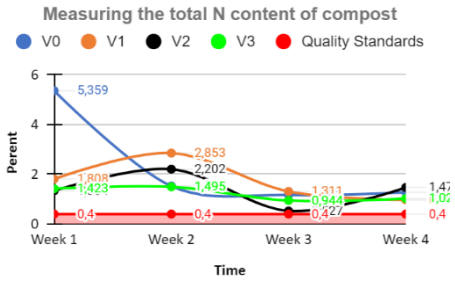

Figure 4. Nitrogen content in compost

Based on the results of measuring the quality of compost N (Nitrogen) contained in **Table 3**, which is compared with the SNI quality standard of 0.4%, it shows that the highest quality results close to the standard are V2, namely 1.471% with the use of a 500-fold dilution of eco-enzyme. The lowest N (nitrogen) results were in v1, namely 0.971% with no enzyme (control). These results show that the use of eco-enzyme has a better impact on the nitrogen content of compost compared to the control without eco-enzyme.

3.2.3. Compost P (Phosphate) Measurement Results

The results of measuring the P (phosphate) content of compost, which was measured once every 7 days during the 28 days of research, showed the following results:

Table 4. Compost P (Phosphate) measurement results

Test P	Vo (%)	V1 (%)	V2 (%)	V3 (%)	Quality standards
Week 1	0.795	0.259	0.213	0.463	0.1 %
Week 2	0.232	0.59	0.278	0.544	
Week 3	0.168	0.718	0.273	0.244	
Week 4	0.307	0.589	0.215	0.363	

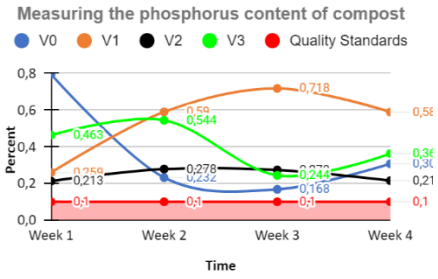

Figure 5. Phosphate content in compost

Based on the results of measuring the quality of P (phosphate) compost in **Table 4**, which is compared with the SNI quality standard of 0.1%, it shows that the highest quality results close to the standard are V1, namely 0.589% with the use of eco-enzyme dilution 1000 times. The lowest P (phosphate) results were in v2, namely 0.215% with a dilution of 500x. These results show that the use of eco-enzyme has a better impact on the phosphate content of compost compared to the control without eco-enzyme.

3.2.4. Compost K (Potassium) Measurement Results

The results of measuring the potassium content of compost, which was measured every 7 days during the 28 days of research, showed the following results.

Table 5. Compost K (Potassium) measurement results

Test K	Vo (%)	V1 (%)	V2 (%)	V3 (%)	Quality standards
Week 1	1.508	0.457	0.192	0.585	0.2 %
Week 2	0.32	1.017	0.509	0.54	
Week 3	0.049	0.066	0.021	0.051	
Week 4	0.136	0.112	0.32	0.085	

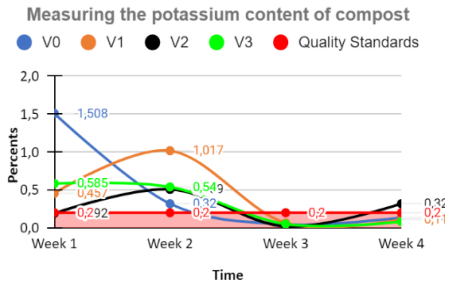

Figure 6. Potassium content in compost

Based on the results of measuring the quality of compost K (potassium) contained in **Table 5**, which is compared with the SNI quality standard of 0.2%, it shows that the highest quality results close to the standard are V2, namely 0.32% with the use of eco-enzyme dilution 500 times. The lowest K (potassium) result was in v3, namely 0.085% with a 200x dilution. These results show that the use of eco-enzyme has a better impact on the potassium content of compost compared to the control without eco-enzyme.

3.2.5. Compost pH Measurement Results

The results of measuring the pH content of the compost, which was measured every 7 days during the 28 days of the study, showed the following results.

Table 6. Compost pH measurement results

Test pH	Vo (%)	V1 (%)	V2 (%)	V3 (%)	Quality standards
Week 1	4.2	4.87	4.97	4.73	6.8 - 7.49
Week 2	3.9	5.43	4.6	4.63	
Week 3	4.27	4.27	4.7	4.3	
Week 4	4,93	4,2	4,73	4,33	

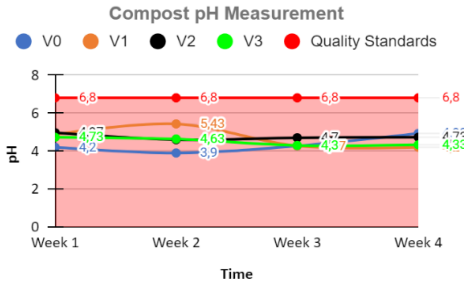

Figure 7. Compost Ph

Based on the results of measuring the quality of the compost pH in **Table 6**, which is compared with the SNI quality standard of 6.8–7.49, it shows that the highest quality result close to the standard is at Vo, namely 4.93 with no eco-enzyme (control). The lowest pH result was v1, namely 4.2 with a 1000x dilution. The condition of the compost has not yet reached the standard or neutral pH condition because the process takes place anaerobically, allowing fermentation to occur and the addition of enzymes, which lower the pH to an acidic level.

3.2.6. Compost Water Content Measurement Results

The results of measuring the water content of the compost, which was measured every 7 days during the 28 days of the study, showed the following results.

Table 7. Compost Water Content measurement results

Test	Vo (%)	V1 (%)	V2 (%)	V3 (%)	Quality standards
Week 1	96,73	92,36	93,97	92,1	50 %
Week 2	91,49	95,01	90,16	89,33	
Week 3	81,45	85,36	80,95	83,11	
Week 4	80,71	78,29	74,52	79,41	

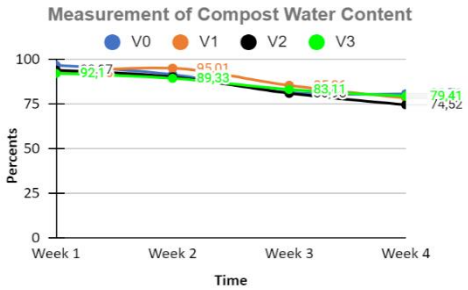

Figure 8. Trend of Water Content in compost

Based on the results of measuring the water content of the compost in Table 4, which is compared with the SNI quality standard of 50%, it shows that the quality results closest to the standard are V2, namely 74.52% with the use of a 500-fold dilution of eco-enzyme. The highest water content results were at vo, namely 80.71% without eco-enzyme (control). These results show that the use of eco-enzyme has a better impact on compost moisture content compared to the control without eco-enzyme.

3.2.7. Results of the Measurement of Compost Volume Decrease

The results of measurements of the decrease in compost volume, which were measured once every 7 days during the 28 days of research, showed the following results.

Table 8. Results of measurements of compost volume reduction

Date	Time	Vo (cm)	V1 (cm)	V2 (cm)	V3 (cm)
Sunday, March 5	Ho	20	20	20	20
Sunday, March 12	H7	17.4	15.7	15	15.4
Sunday, March 19	H14	15.9	14.7	13.8	13.7
Sunday, March 26	H21	14.9	12.4	12	12.2
Sunday, April 2	H28	11.4	7.9	9.5	10
Total Waste Reduction (cm)		8.6	12.1	10.5	10
Abatement Effectiveness (%)		**43.00 %**	**60.50 %**	**52.50%**	**50.00 %**

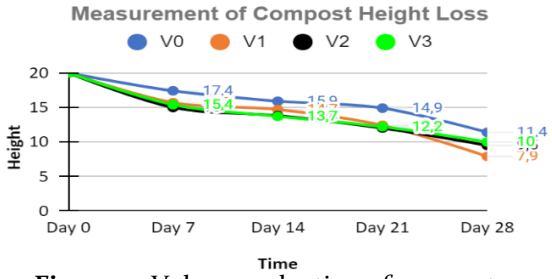

Figure 9. Volume reduction of compost

Based on the results of measurements of the reduction in compost volume contained in **Table 8**, comparing the reduction in compost volume between treatments and control, it is stated that the highest reduction results were in V1, namely 60.50% with the eco-enzyme treatment dilution of 1000 x. The lowest reduction result was in vo, namely 43% without eco-enzyme (control). These results show that the use of eco-enzyme has a better impact on reducing volume during composting compared to the control without eco-enzyme.

3.3 Quality Effect of Eco-Enzyme on Leachate Quality

The effect of eco-enzymes on compost quality takes into account the physical and chemical parameters of leachate, which are compared with leachate water quality standards. The leachate quality standard used is the Republic of Indonesia Minister of Environment and Forestry Regulation No. P.59/Menlhk/Setjen/Kum.1/7/2016 concerning leachate quality standards for businesses and/or activities at final waste processing sites. The leachate quality parameters that are considered are COD, BOD, TSS, total N, and leachate pH. The test results for each parameter obtained the following results.

3.3.1. Leachate COD Measurement Results

The results of measuring the COD (chemical oxygen demand) concentration of leachate, which was measured every 7 days during the 28 days of the study, showed the following results:

Table 9. Results of leachate COD concentration measurements

Test COD	Vo (%)	V1 (%)	V2 (%)	V3 (%)	Quality standards
Week 1	900	850	821	903.33	300 mg/L
Week 2	976.67	863.33	890	940	
Week 3	821	630	746.67	730	
Week 4	866.67	640	466.67	783.3	

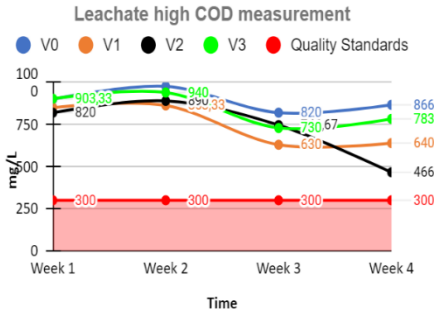

Figure 9. COD concentration in compost leachate

Based on the results of measuring the leachate COD concentration in **Table 9,** which is compared with the leachate quality standard of 300 mg/l, it shows that the leachate concentration results are close to the standard at V2, namely 466.66 mg/l, with the use of a 500x dilution of eco-enzyme. The highest COD concentration results were at vo, namely 866.67 mg/l without the use of eco-enzyme (control). These results indicate that the use of eco-enzyme has a better impact on leachate COD concentrations compared to controls without eco-enzyme.

3.3.2. Leachate BOD Measurement Results

The results of measuring BOD (biochemical oxygen demand) leachate concentrations, which were measured once every 7 days during the 28 days of the study, showed the following results.

Table 10. Results of leachate BOD concentration measurements

Test BOD	Vo (%)	V1 (%)	V2 (%)	V3 (%)	Quality standards
Week 1	2190	1760	1800	1890	150 mg/L
Week 2	3500	4300	2400	4420	
Week 3	4330	4670	4650	4920	
Week 4	7862	6492	6272	7572	

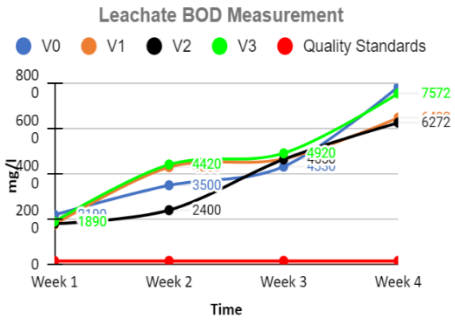

Figure 10. BOD concentration in compost leachate

Based on the results of measuring the leachate BOD concentration in **Table 10**, which is compared with the leachate quality standard of 150 mg/l, it shows that the leachate concentration results increase every week. This is because the treatment carried out on the waste uses biological enzymes, so the leachate produced has a high BOD content to degrade the high biological pollutants in the leachate. The BOD concentration that is close to the quality standard is V2, namely 6272 mg/l with the use of a 500x dilution of eco-enzyme. The highest BOD concentration results were at v0, namely 7862 mg/l without the use of eco-enzyme (control). These results indicate that the use of eco-enzyme has a better impact on leachate BOD concentrations compared to controls without eco-enzyme.

3.3.3. Leachate TSS Measurement Results

The results of measuring the TSS (total suspended solid) concentration of leachate, which were measured once every 7 days during the 28 days of the study, showed the following results:

Table 11. Leachate TSS concentration measurement results

Test TSS	Vo (%)	V1 (%)	V2 (%)	V3 (%)	Quality standards
Week 1	790	860	500	690	100 mg/L
Week 2	1640	3210	1820	1680	
Week 3	1660	1720	1680	1200	
Week 4	1280	720	550	1220	

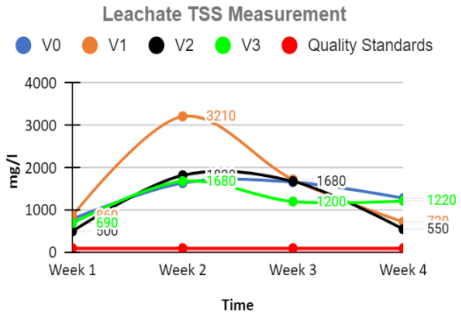

Figure 11. TSS concentration in compost leachate

Based on the results of measurements of the leachate TSS concentration contained in **Table 11**, which is compared with the leachate quality standard of 100 mg/l, it shows that the TSS concentration that is close to the quality standard is at V2, namely 550 mg/l with the use of a 500x dilution of eco-enzyme. The highest TSS concentration results were at v0, namely 1280 mg/l without the use of eco-

enzyme (control). These results indicate that the use of eco-enzyme has a better impact on leachate TSS concentrations compared to controls without eco-enzyme.

3.3.4. Total Leachate N (Nitrogen) Measurement Results

The results of measuring the total N (nitrogen) concentration of leachate, which were measured every 7 days during the 28 days of the study, showed the following results:

Table 12. Leachate N concentration measurement results

Test N	Vo (%)	V1 (%)	V2 (%)	V3 (%)	Quality standards
Week 1	53.48	36.95	42.48	55.19	60 mg/L
Week 2	24.95	32	32.81	31.81	
Week 3	24.19	16.14	23	16.48	
Week 4	23.95	18.52	25.57	16	

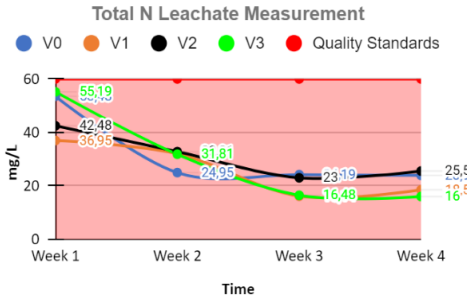

Figure 12. Nitrogen concentration in compost leachate

Based on the results of measuring the total N concentration of leachate in **Table 12**, which is compared with the leachate quality standard of 60 mg/l, it shows that the total N concentration of all variations meets the quality standard. However, the N concentration that is close to the quality standard is at V3, namely 16 mg/l, with the use of a 200x dilution of eco-enzyme. The highest total N concentration results were in v2, namely 25.57 mg/l using a 500x dilution of eco-enzyme. These results indicate that the use of eco-enzyme has a better impact on leachate N concentrations compared to controls without eco-enzyme.

3.3.5. Leachate pH Measurement Results

The results of measuring the pH content of the leachate, which were measured every 7 days during the 28 days of the study, showed the following results:

Table 13. Leachate pH Measurement

Test pH	Vo (%)	V1 (%)	V2 (%)	V3 (%)	Quality standards
Week 1	6.34	6.43	6.61	6.43	6-9
Week 2	6.22	6.93	6.67	6.94	
Week 3	7.44	7.58	7.46	7.8	
Week 4	8.08	7.81	8.47	8.51	

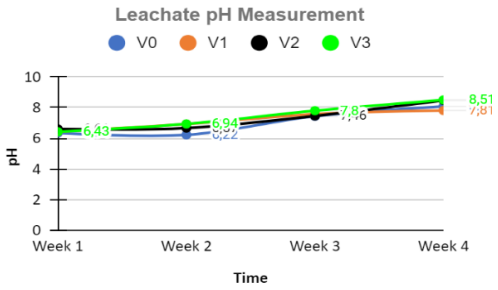

Figure 13. pH in compost leachate

Based on the results of measuring the pH quality of the leachate in Table 13, which is compared with the leachate quality standard of 6–9, it shows that the results of all pH levels meet the quality standard. However, the pH quality is better the closer it is to neutral; therefore, the pH of the leachate is closer to the quality standard, namely V1, namely 7.81, with the use of a 1000x dilution eco-enzyme. The highest pH result is v3, namely 8.51 with the use of a dilution enzyme 200x.

3.4 Effect of Eco-Enzyme on Methane Gas Production

The effect of eco-enzymes on the volume of methane gas production for each treatment Methane gas volume measurements were measured once every 3 days for 31 days, resulting in 10 data points. Methane gas production volume data was compared between eco-enzyme treatment and without eco-enzyme (control). From the data obtained, we will see the fastest data in reaching the maximum point phase of methane gas production (methanogenesis). Methane gas production data is in the following table.

Table 14. Methane Gas Production Measurement Results

Day	Day 0	Day 4	Day 7	Day 10	Day 13	Day 16	Day 19	Day 22	Day 25	Day 28	Day 31
Vo	0	2,4	4	1,8	2,5	2	3,4	2,4	2,1	2,5	2,8
V1	0	2,4	3,8	2,5	2,9	2,1	3,2	2,7	4,4	2,2	2
V2	0	2,1	3,9	3	3,3	3,4	3,6	3,8	7,6	2,3	1,7
V3	0	2	4,1	3,8	3	3,9	4,7	4,1	5,6	2,5	1,9

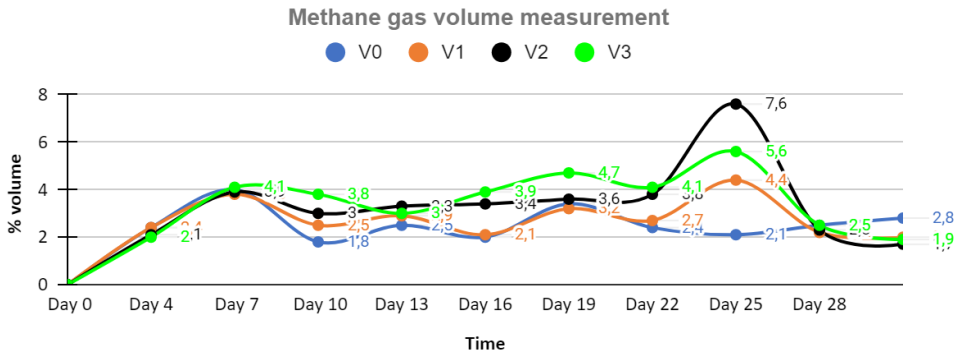

Figure 14. Methane Gas Production Measurement in Compost

Based on the results of measurements of methane gas production in Table 14, it can be seen that on day 25, there was a peak in methane gas production, and on day 28, there was an intersection point for the volume of methane gas production. V1 produces 4.4% methane volume, V2 produces 7.6%

methane volume, and V3 produces 5.6% methane volume and has reached the highest point of methane gas production (methanogenesis phase). This is appropriate because on the 28th and 31st days, methane gas production in V1, V2, and V3 decreased. V0 on day 25 produces 2.1% methane volume, but on days 28 and 31, methane gas production increases, so V0 has not yet reached the highest point of methane gas production (the methanogenesis phase). Based on these results, it can be concluded that the use of eco-enzyme in the waste decomposition process is able to speed up the decomposition process, characterized by faster production of methane gas compared to V0 (control) without using eco-enzyme.

4 Conclusions

The conclusion from research on the impact of using eco-enzymes on the impact of composting, namely on compost quality parameters compared to SNI 19-7030-2004 concerning compost specifications from domestic organic waste, is that the parameters C, N, P, and K are better and meet the standard criteria for compost compared to without using eco-enzymes. The pH parameter tends to be better without using eco-enzyme because of the impact of using eco-enzyme so that the pH will decrease. In measuring the volume reduction, the most effective reduction results were obtained in V1 with an eco-enzyme dilution of 1000 times. The impact of the use of eco-enzyme on the quality of the leachate produced is compared with the Republic of Indonesia Minister of Environment and Forestry Regulation No. P.59/Menlhk/Setjen/Kum.1/7/2016 concerning leachate quality standards. It was found that leachate results using eco-enzyme on the parameters COD, BOD, TSS, total N, and pH had better quality than without using eco-enzyme enzyme (control). These parameters also have a quality that is close to leachate water quality standards. The impact of using eco-enzymes on methane gas production was found to be that waste treated with eco-enzymes reached the methanogenesis phase more quickly on the 25th day and decreased on the following day, whereas waste without eco-enzymes had not yet reached the methanogenesis phase. and methane production rose the following day.

Acknowledgments

The author would like to thank the lecturers at Environmental Engineering, Diponegoro University, who have provided insights and expertise that were very helpful in completing this research.

References

Damanhuri, E., & Padmi, T. (2010). Pengelolaan sampah. Diktat Kuliah TL, 3104, 5–10.

IPCC. 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Vol 5, Waste, Chapter 3, Solid Waste Disposal.

Muliarta, I. N., Sudita, I. D. N., & Situmeang, Y. P. 2023. The Effect of *Eco-enzyme* Spraying on Suwung Landfill Waste, Denpasar, on Changes in Leachate Characteristics. Journal of Environmental Health, 15(1).

Nurfajriah, et al. (2021). Pelatihan Pembuatan *Eco-enzyme* Sebagai Usaha Pengolahan Sampah Organik Pada Level Rumah Tangga. Jurnal Ikraith-Abdimas.3(4):194-197.

Park, Jin-Won., Shin, Ho-Chul. 2011. Surface emission of landfill gas from solid waste landfill. Journal Atmospheric Environment, edition: 35 (2011) 3445–3451

Pratamadina, Efli & Wikaningrum, Temmy. (2022). Potensi Penggunaan Eco Enzyme pada Degradasi Deterjen dalam Air Limbah Domestik. Jurnal Serambi Engineering. 7. 10.32672/jse.v7i1.3881.

(SIPSN), S. I. (2022). Grafik komposisi sampah berdasarkan jenis sampah. Kota Semarang: Menteri Lingkungan HIdup dan Kehutanan.

Susanto, P.J., Ganefati P.S., Muryani, S., dan Istiqomah, H.S., 2004. Pengolahan Lindi (Leachate) dari TPA dengan Menggunakan Sistem Koagulasi Biofilter Anaerobic. Jurnal Teknologi Lingkungan, 5:167-173

Tchobanoglous, George. Theisen, Hilary. Vigil, Samuel.1993. Integrated Solid Waste Management. Mc Graw-Hill, Inc. New York.