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THE EFFECT OF ECO-ENZYME SPRAYING ON SUWUNG LANDFILL WASTE, DENPASAR, ON CHANGES IN LEACHATE CHARACTERISTICS

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Abstract

Introduction: *Bali, as an international tourist destination, is still experiencing problems in waste management. Suwung Landfill, Denpasar, is one of the landfills for waste originating from the Denpasar, Badung, Gianyar, and Tabanan (Sarbagita) areas.* ***Methods:*** *This research was an experimental study, by watering eco-enzymes on garbage heaps and examining changes in leachate parameters. Watering was carried out daily at a dose of 1 L of eco-enzyme dissolved in 1000 L of water and used for watering a garbage pile of 1 ha. The area of piles of garbage watered with eco-enzymes reaches 5 ha. Measured leachate parameters include pH, BOD, COD, TSS, N, cadmium, and mercury.* ***Results and Discussion:*** *Eco-enzymes have the potential to become activators or decomposers in waste composting. The evidence is that eco-enzyme watering causes the average leachate temperature to range from 36.63 to 40.370C, where the increase in leachate temperature occurs due to the rise in the temperature of the garbage pile. An increase in temperature characterizes the activity of microbes increases, so the decomposition process becomes rapid.* ***Conclusion:*** *Eco-enzyme spraying leads to a characteristic change in the form of an increase in the value of leachate parameters. The increase in temperature value, pH, BOD, COD, and N content of leachate indicates that environmentally friendly enzymes accelerate the decomposition of organic matter. The rapid decomposition process causes the total suspended density of leachate to increase.*

INTRODUCTION

Waste is the result of human efforts to meet the needs of life needs. Solid waste that continues accumulating in the environment will have negative impacts that can interfere with human life (1). Waste disposal is a serious problem, both in cities and in villages, and both in developed and developing countries. Waste management solutions must be economically sustainable, technically feasible, socially acceptable legally, and context-friendly (2). Incorrect waste management will impact soil pollution, and groundwater, and can be a source of disease spread (3). Various efforts have been made to create better waste management, but the steps taken are still far from expectations. Creative solutions are needed to overcome this pressing problem (4).

The involvement of the government, the community, and stakeholders is vital to achieve the best waste management practices. The government as a policyholder must establish strict household and industry waste management guidelines (5). Increasing public and private participation is the key to the success of the implementation of waste management (6). Whether in the form of cash or the distribution of recycled items, government support is crucial for encouraging the community to reduce its waste output and inspiring other communities to undertake similar initiatives (5).

Around 67.8 million tons of waste are produced in Indonesia each year. Another issue brought on by the ever-growing garbage heap is leachate or waste-derived water (7). Leachate is also created when water from outside sources, including drainage, rains, and so forth, seeps through waste in landfills (8). Leachate contains organic and inorganic compounds with concentrations of ammonia, nitrates, nitrites, sulfides, heavy metals,

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nitrogen, and other pollutants in the form of suspended particles and dissolved solid contaminants (8–10). Leachate has the potential to contaminate groundwater and the environment due to the high quantity of toxins it contains (8,11). Leachate typically has high Chemical Oxygen Demand (COD) values, ranging from 6000 to 60000 mg/L, and Biological Oxygen Demand (BOD) levels between 4000 and 13000 mg/L (12).

Reducing waste production can be one way to minimize problems in waste management. Reduction efforts can be a sustainable solution to mitigate global warming and reduce pressure on natural resources (13). The rest of the vegetables, fruits, and fruit peels that are kitchen waste can be used as eco-enzymes. Eco-enzyme production provides a double advantage because it can reduce waste management's burden and even be used in agriculture, animal husbandry, domestic cleaning, and others (14).

The Organic Farming Association of Thailand and has been researching since the 1980s, coined the phrase "eco-enzyme" initially. Eco-enzymes were introduced more widely by a Naturopathic researcher from Penang, Malaysia (15). Fruit peels and vegetable waste from the kitchen are fermented to produce eco-enzyme, an organic substance that forms a complex solution. Fruit peels and vegetable waste from the kitchen are fermented to produce eco-enzyme, an organic substance that takes the form of a complex solution (16). The manufacture of eco-enzymes is conducted by combining sugar, fresh waste (fruits and vegetables), as well as water in a ratio of 1: 3: 10, which is then fermented on average for 3 months (15). Processing household waste to be used as eco-enzymes is the first step in implementing the concept of zero waste at the household level. The commitment to waste enzyme production becomes an integrated effort in reusing waste so that the volume of wasted materials is getting smaller, even becoming non-existent or zero (16). Due to the ongoing demand, the manufacturing of enzymes utilizing organic waste or eco enzymes has attracted a lot of attention in recent years (17). Efforts to maximize the production of environmentally friendly enzymes on a large scale should be possible, with higher hydrolytic enzyme activity (18). Using eco-enzymes can reduce the removal of methane gas from waste and economically save money (14,19). The use of eco-enzymes in agriculture can help plants grow better and faster (14).

Eco enzyme production provides double benefits. In addition to reducing the burden on organic waste management, it also provides benefits when in applications in agriculture, animal husbandry, cleaning and others (20). Eco-enzymes so far have been widely used in sewage treatment, such as in sewage sludge treatment. The evidence is that the application of eco-enzymes has a statistically significant effect on improving pH, COD, and decreasing organic content in sewage sludge (21). Another advantage is that it can inhibit the growth of microorganisms in liquid waste, including the ability to process metal-based waste. The sludge applied by eco-enzymes also has the potential to increase the growth of chili and aloe vera (22).

Eco enzyme contains the enzymes amylase, trypsin, and lipase. The lipase enzyme has biocatalystator properties that can help the process of degradation of surfactants in detergents. This proves that eco enzymes can help the detergent degradation process in domestic wastewater (23). Eco-Enzym from the combination of household organic waste and Cambodian flowers (*Plumeria alba*) has the ability to inhibit the growth of *Staphylococcus aureus* with a powerful inhibitory power category that reaches 31.85-34.41 mm, making this mixture a useful natural disinfectant. This eco-enzyme, with a duration of 8-10 days has an alcohol content of 60-70% (24).

The Suwung landfill is the largest in Bali and is a landfill location for waste originating from Denpasar, Badung, Gianyar, and Tabanan (Sarbagita) (25). The composition of waste in the Suwung landfill is dominated by organic waste, around 78.1%, and inorganic waste, at 21.9%. The organic waste is 45.71% in the form of garden residues, 17.71% in the form of food waste, and 1.48% in rubber and leather. Its inorganic waste consists of plastic at 19.26% and metal at 0.54% (26).

The method of disposing of waste in the landfill will have an impact on reducing environmental quality, where there is air pollution due to burning, groundwater pollution as a result of washing, and an increasing number of diseases that can endanger the health of scavengers and residents (27). Landfill leachate is hazardous for the environment and human health. Toxicity test results show that a greater amount of leachate results in stunted plant growth (28).

So far, waste generation in the Suwung landfill has produced leachate which causes dug well water in the Banjar Suwung Batan Kendal area of South Denpasar to be polluted with lead with content varying between 0.0060 mg/L to 0.1023 mg/L (29). A variety of landfill leachate processing technologies are available. Technology selection must consider cost factors, leachate characteristics, annual rainfall data, and others (12).

Based on the results of previous studies, it is necessary to conduct trials on the use of eco-enzymes to change the leachate parameters of garbage piles in landfills. Moreover, no one has used eco-enzymes to deal with the problem of waste in landfills. This research is essential in reducing pollution due to leachate and realizing optimal waste management at a low cost in Bali.

METHODS

This research was an experimental study, through spraying eco-enzymes on waste piles at the Suwung landfill. sprayed eco-enzyme was carried out every day for one month at 16.00-17.00 WITA. Every 1 L of eco-enzymes used was dissolved in 1,000 L of water which was then used to spray a 1 ha pile of waste. The area of garbage piles in the Suwung landfill sprayed with an eco-enzyme solution was 5 hectares. The characteristics of eco-enzymes used in this study are (Table 1):

Table 1. Characteristics of Eco-Enzymes

Parameters	Value	Unit
pH	3.67	-
TDS	1102	mg/L
BOD	85.5	mg/L
COD	167	mg/L
MPN	< 3	CFU/100 ml

The eco-enzyme spraying in this study utilized a water sprayer tank truck owned by the Technical Implementation Unit of the Suwung Denpasar Landfill Management Area. Watering also involved the help of a water spray tank car from the Denpasar City Fire Unit. The eco-enzyme watering process in this study was not followed by a reversal of the waste pile, due to the high level of waste piles at the Suwung landfill, Denpasar.

To find out the changes in leachate characteristics after spraying, leachate sampling was done every Monday from 09.00-11.00 WITA. Leachate retrieval was completed at 3 points of the lower leachate channel of the garbage mountain (Figure 1). Testing of leachate parameters was carried out at the Regional Technical Implementation Unit of the Bali Provincial Environmental Laboratory and the Bali Provincial Regional Health Laboratory.

Leachate sampling for laboratory tests was undertaken with the help of mobile lab vehicles of the Environment Agency, Bali Province. The parameters measured in this study were guided by the provisions of the Minister of Environment and Forestry of the Republic of Indonesia Number P.59 /MENLHK/SETJEN/KUM.1/7/2016 concerning Quality Standards for Business Leachate and/or Activities of Waste End Treatment Sites (Table 2).

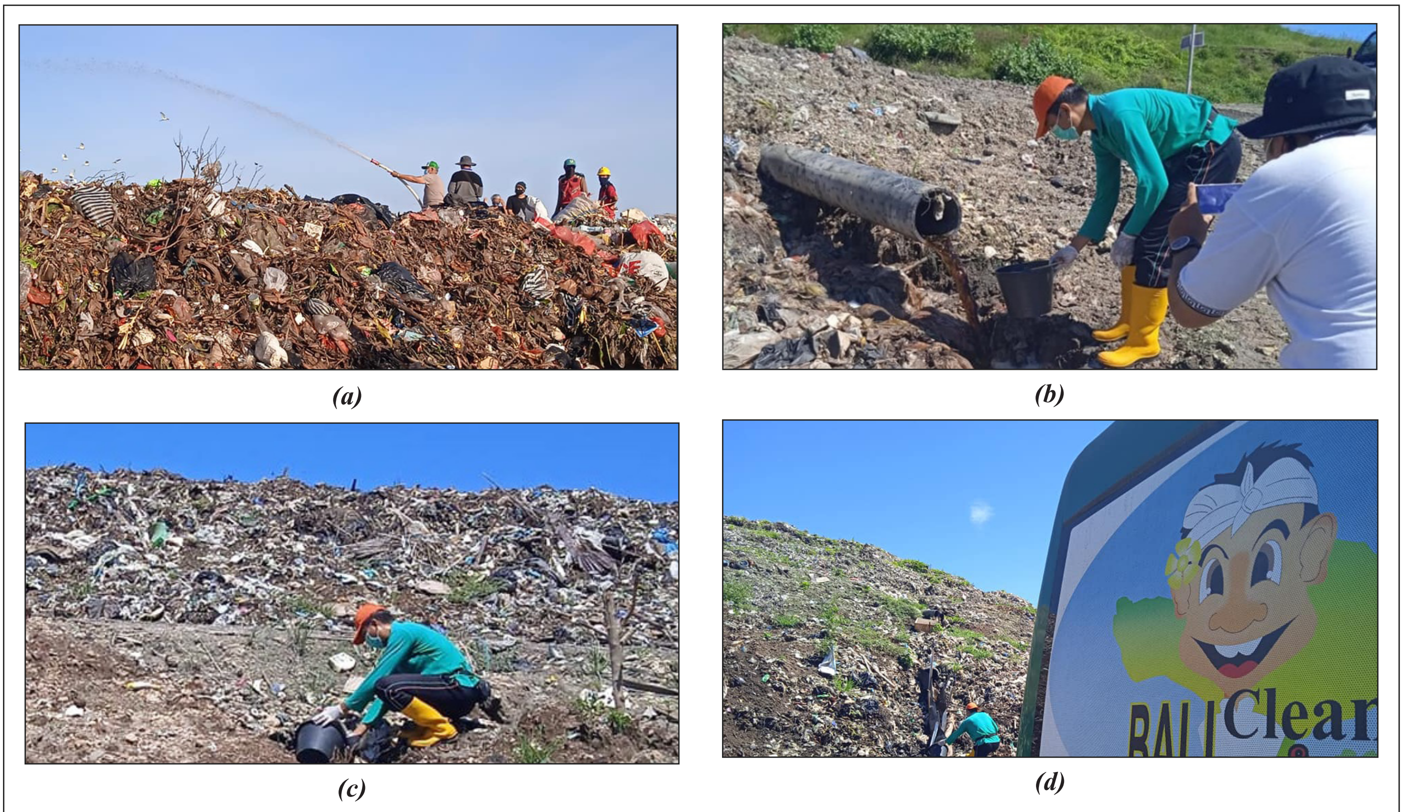

Figure 1. Spraying Eco-Enzyme *(a)* and Sampling Leachate at 3 Points: *(b)*: 08.72235 ^{0}S, 115.22203 ^{0}E, *(c)*: 08.72341 ^{0}S, 115.22198 ^{0}E, and *(d)*: 08.72427 ^{0}S, 115.22153 ^{0}E

Table 2. Parameters and Methods of Leachate Quality Testing

Parameters	Methods/tools used	Quality Standards*	Unit
pH	SNI 06-6989 11-2004/pH 2011 ATC	6-9	-
BOD	SNI 06-6989 72-2009/Buret	150	mg/L
COD	SNI 06-6989 73-2009/Buret	300	mg/L
TSS	SNI 06-6989 3-2004	100	mg/L
N Total	Spectrophotometer UV-Vis	60	mg/L
Mercury	Atomic Absorption Spectrophotometer (AAS)	0.005	mg/L
Cadmium	Atomic Absorption Spectrophotometer (AAS)	0.1	mg/L

**Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number P.59/MENLHK/SETJEN/KUM.1/7/2016*

The collected leachate parameter data was averaged and analyzed by creating a graph to determine the trend of leachate quality changes. Leachate parameters were then compared with the Provisions of the Minister of Environment and Forestry of the Republic of Indonesia regarding leachate quality standards for businesses and/or activities of waste final processing sites as stated in regulation Number P.59 /MENLHK/ SETJEN /KUM.1/7/2016.

RESULTS

The Suwung landfill is an open landfill covering an area of 32.4 ha. This regional landfill receives waste of up to ± 1,400 tons per day from the Denpasar City area, Badung Regency, Gianyar Regency, and Tabanan Regency. The composition of incoming waste is dominated by organic waste reaching 78.1% and inorganic waste at 21.9% (26). TPA Suwung has leachate quality with TDS of 3,314 mg/L, BOD of 985.6 mg/l and COD of 1,760 mg/L (30).

The wells of residents around the Suwung landfill are suspected of having been polluted with leachate. The material that pollutes the well water of residents around the Sarbagita Regional Landfill is Lead (Pb), Cyanide group (CN), and is indicated to be contaminated with *E. coli* and coliform. The parameters of Cyanide (CN) and Lead (Pb) in the sample were 0.024 mg/L and 1.6997 mg/L. The measurement results of *E. coli* and coliform in samples were very high, namely the MPN values of 9/100 ml and 1100/100 ml (31). Water quality around the landfill also experienced an increase in DO parameter values reaching 5.9 mg/L (32). It is estimated that Bali's largest landfill leachate potential is around 3.84 l/sec. Maximum gas production is predicted to reach 43,367,678.25 m^3 per year which occurs in 2023. Gas production is expected to run out by 2034 after experiencing a gradual decline in production (33).

The mitigation of pollution caused by the Suwung landfill is still minimal in its application, especially for odor problems that make the surrounding environment disturbed. The solution that should be done so as not to add more damage and pollution is to use plants that are used as buffers to limit landfill facilities to the surrounding environment (34). Landfill leachate must be well controlled following applicable regulations so that the water quality around the landfill is not polluted (32).

Leachate temperatures after spraying eco-enzyme on garbage in Landfill Suwung on average range from 36.63 to 40.37^{0}C (Figure 2). Measured leachate temperature tends to be higher than leachate temperature without spraying. So spraying eco-enzyme actually causes an increase in the temperature of the garbage pile which results in an increase in the temperature of leachate. The increase in temperature is an indicator that eco-enzyme has the potential as an activator to speed up the composting process.

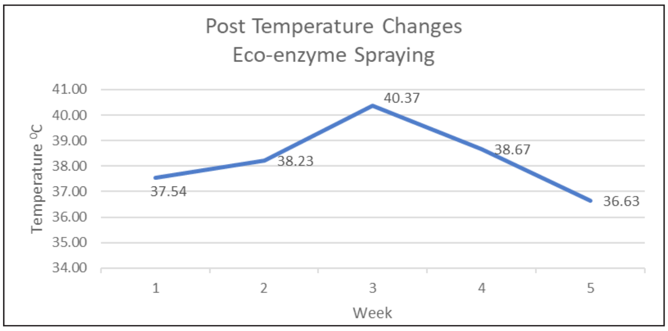

Figure 2. Changes in Temperature after Spraying Eco-Enzyme

The average pH level of leachate water after watering eco-enzyme ranges from 7.66–7.91 (Figure 3). The change in pH is an indicator of the decomposition process in waste which then has an impact on leachate. In general, the pH of leachate after watering eco-enzymes is still following the quality standards that require 6-9 following the provisions of the Minister of Environment and Forestry of the Republic of Indonesia regarding leachate quality standards for businesses and/or activities of the final processing site of waste as stated in the regulation Number P.59/MENLHK/SETJEN/KUM.1/7/2016.

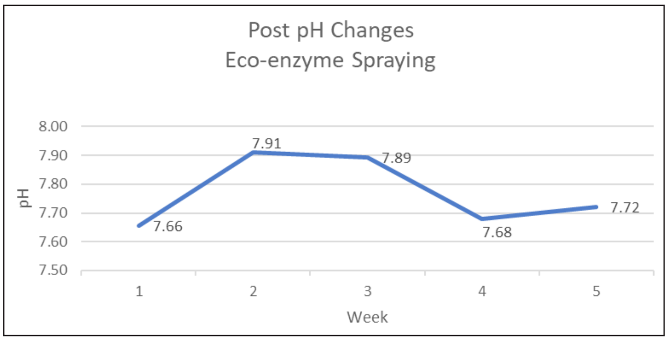

Figure 3. Changes in pH Leachate after Spraying Eco-Enzyme

There was an increase in Total Suspended Solid (TSS) from the first week after spraying eco-enzyme to the fifth week at 62.27%. TSS leachate landfill waste Suwung ranges from 8.31 mg/L to 14.88 mg/L (Figure 4). In general, TSS is still below the quality standard set at 100 mg/L in accordance with the provisions of the Minister of Environment and Forestry of the Republic of Indonesia regarding leachate quality standards for businesses and/or activities of waste final processing sites as stated in regulation Number P.59/MENLHK/SETJEN/KUM.1/7/2016.

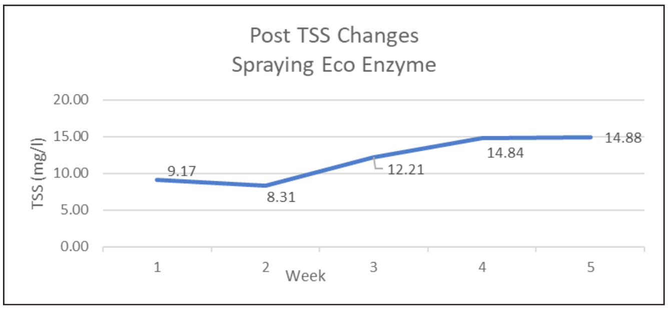

Figure 4. Impact of Eco-Enzyme Watering on TSS Leachate

Spraying eco-enzyme directly has no impact on BOD leachate improvement in TPA Suwung. Spraying precisely causes BOD parameters to increase or worsen the quality of leachate (Figure 5). In general, the BOD of leachate ranges from 321.51–439.88 mg/L or exceeds the threshold set in the provisions of the leachate quality standard contained in rule Number P.59/MENLHK/SETJEN/KUM.1/7/2016 of 150 mg/L.

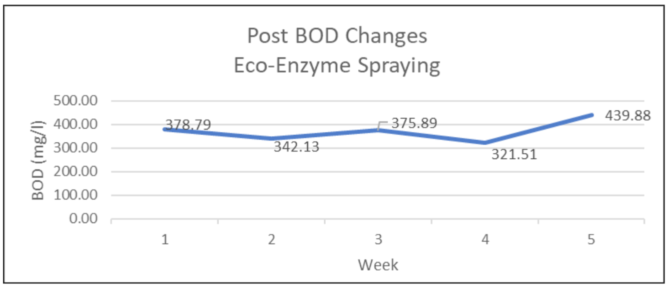

Figure 5. Impact of Eco-Enzyme Spraying on BOD Leachate

COD after eco-enzyme spraying increased from 1271.24–2218.39 mg/L (Figure 6). Spraying does not produce better COD, because the value of COD actually increases. Based on the provisions of the Minister of Environment and Forestry of the Republic of Indonesia regarding leachate quality standards for businesses and/or activities of waste final processing sites requires a COD threshold in the leachate of 300 mg/L. High COD is an indicator of the high oxygen needed by microorganisms to decompose organic matter, both easy to decompose and difficult to decompose.

Spraying eco-enzyme leads to a gradual increase in N total leachate levels. N levels of total leachate from the first week to the fifth week, on average ranged from 2066.01–7458.58 mg/L (Figure 7). The effect of spraying causes the total N level to be further away from the quality standard set at 60 mg/L by the provisions of the Minister of Environment and Forestry of the Republic of Indonesia as stated in regulation Number P.59/MENLHK/SETJEN/KUM.1/ 7/2016.

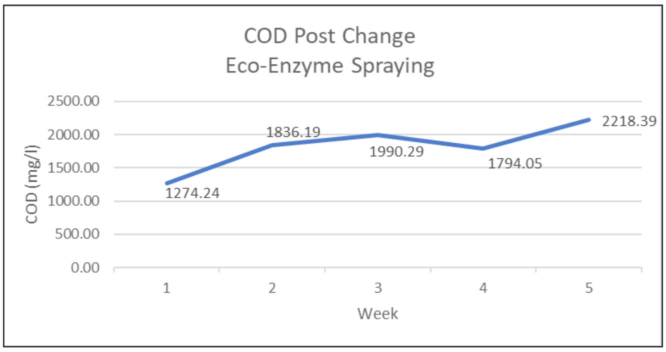

Figure 6. Impact of Eco-Enzyme Spraying on COD Leachate

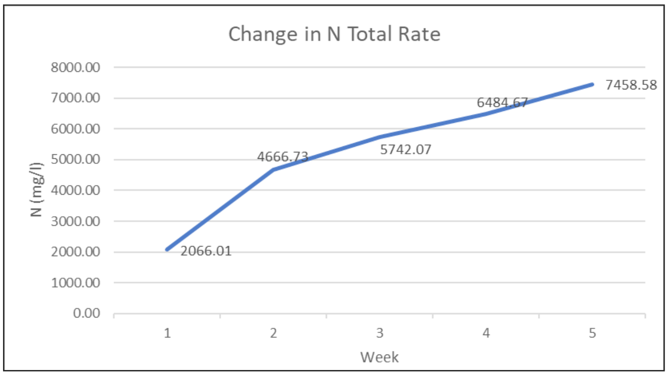

Figure 7. Changes in N Leachate Levels after Eco-Enzyme Spraying

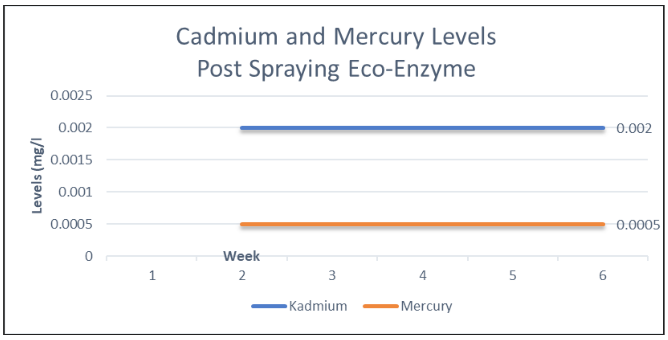

Figure 8. Cadmium and Mercury Levels in Leachate after Spraying Eco-Enzyme

Spraying eco-enzyme does not cause changes in cadmium or mercury levels in leachate. From the first to fifth weeks cadmium levels remained constant at 0.002 mg/L and Mercury levels at 0.0005 mg/L (Figure 8). The content of the two heavy metals in leachate is still far below the quality standards required based on the provisions of the Minister of Environment and Forestry of the Republic of Indonesia regarding leachate quality standards for businesses and/or activities of waste final processing sites as stated in regulation Number P.59/MENLHK/SETJEN/KUM.1/7/2016. The standard limit of cadmium levels in leachate allowed a maximum of 0.1 mg/L and mercury 0.005 mg/L.

DISCUSSION

Leachate Temperature After Spraying Eco-Enzyme

Leachate temperature is related to the temperature of the garbage pile that is degraded due to microbial activity. It is suspected that watering eco-enzymes contributes to increased population and activity of microbes. This conjecture follows the conclusion in a simulation experiment in China in 2022 that the rapid degradation of waste causes the temperature of landfills to rise rapidly (35). The highest temperature of leachate occurs in a new pile of garbage, compared to the old pile of garbage. The temperature has a very important role in the process of decomposition of organic matter and the development of microbial communities (36). Higher temperatures and humidity will stimulate the decomposition process, but it largely depends on the availability of carbon elements and microbial metabolic activity (37).

Heat is generated from the activity of microbes. The higher the temperature, the more oxygen consumption and the faster the decomposition process. If the optimum temperature of microorganisms is reached, the composting process will run optimally as well (38). The presence of temperature changes indicates if the organic matter passes through the stages of mesophilic, thermophilic, cooling, and maturation (38–39).

Microorganisms play an important role in decomposition because their enzymes break down organics into smaller and more stable matter (39). The increase in temperature is an indicator of the active activity of microorganisms in decomposing organic matter (38). Six common bio-activators are used to speed up the decomposition process and obtain mature and quality decomposition results. Waste is an excellent medium for the growth of microorganisms, and can be used as a bio activator in the decomposition process (40). Based on this analysis, it can be concluded that eco-enzymes have the potential to be activators in the decomposition of waste.

Acidity Leachate Post Spraying Eco-Enzyme

The degradation of organic matter to produce ammonia and carbon dioxide is an important factor that contributes to changes in the pH of leachate. As a result of the degradation of organic matter, it dissolves in leachate to produce ammonium ions and carbonic acid. Carbonic acid then easily dissociates into hydrogen cations and bicarbonate anions, affecting the pH value (41). The pH of leachate having a value above 7.5 is a clue that the life of the garbage pile has reached more than 10 years (8). The pH value tends to rise due to the activity of microorganisms in degrading the acid. Unstable acids will decompose into oxides and non-metallic water (42).

Generally, the pH value affects the decomposition process of organic substrates dissolved in leachate, where decomposition will run very slowly under low pH conditions because acidic conditions interfere with the activity of decomposing bacteria (43). The decrease in pH in the early stages is due to the oxidation of organic compounds, and the acidification effect of the biochemical conversion of ammonium (44). The alkaline properties of leachate are characteristic of a mature landfill's methanogenic and leachate phases (45). The PH of young leachate is less than 6.5, while it is further increasing with leachate aging (46).

pH also significantly affects the distribution of microorganisms (47). Experimentally, changes in pH significantly affect the population of bacteria; they can facilitate or inhibit growth, and in extreme cases will lead to the extinction of the bacterial population (48). Fluctuating pH values may be associated with microbial growth, which exerts a greater effect on changes in the composition of leachate (46). Leachate usually has a pH of 6 to 9, thus making it alkaline (49).

TSS Leachate Post-Spraying Eco-Enzyme

The increase in TSS is thought to have occurred due to the increasing accumulation of the results of waste decomposition by microbes after watering eco-enzymes. The accumulation of ever-increasing decomposition results causes the turbidity of leachate increasing. This hypothesis follows the results of a study at the Sukawinata Palembang landfill in 2020, which stated that decomposition produces suspended particles with a larger diameter than dissolved solids, is clearer, and causes increased turbidity (50). Whereas if there are fewer or lower TSS levels in leachate, the better and more environmentally friendly the quality of leachate (51). The increase in turbidity characterized by an increase in TSS suggests that watering eco-enzymes accelerates the decomposition process of waste in the Suwung landfill.

Landfill leachate is commonly known as wastewater that is very difficult to handle and contains suspended substances (52). TSS is referred to as a non-filterable residue. This means that the less TSS contained in leachate waste, the better (51). High TSS values of leachate and exceeding the quality standard limit if left untreated will affect water quality (49).

BOD Leachate Post-Spraying Eco-Enzyme

The increase in BOD parameters is thought to be related to an increase in the decomposition of organic matter suspended in leachate. This conjecture also relates to an increase in leachate TSS characterized by an increase in the level of leachate turbidity. The BOD in leachate that continues to rise is a clue to the amount of decomposed organic matter that continues to grow.

Measurements of the dissolved oxygen that microorganisms employ in the biochemical oxidation of organic molecules are included in BOD (53). Leachate has different concentrations of organic matter and biodegradability levels, which are strongly influenced by the age of the landfill and must be treated with appropriate techniques to protect the environment and water resources (54).

BOD It is the oxygen needed or consumed to maintain the decomposition of microbes against organic matter in water or wastewater (41). Increased BOD is associated with high microbial activity (55). High BOD values suggest that leachate cannot remove too many organic materials on its own (49). Leachate contains a high concentration of organic ingredients, chemical and bacterial elements, and heavy metals. Direct discharge into nature without any treatment will cause water pollution (49,56). Leachate water coming from landfills is a serious problem. This is because leachate water can pollute the wells of residents around the landfill (57).

COD Leachate Post-Spraying Eco-Enzyme

The high COD rate of leachate is thought to be related to waste doused with eco-enzymes new waste. Considering that new piles of garbage are added every day to the Suwung landfill, Denpasar. The high COD indicates that the age of the waste is still young and is a clue that the waste is nailing the methanogenic phase (53). High amounts of contaminants and substrates for humic acid that cannot be stabilized by microbes can also be the cause of high COD values (49).

The amount of oxygen needed to convert organic waste into inorganic stuff is measured by COD (55). The results of research at the Sukawinata landfill in Palembang in 2020 also found that high COD is an indicator of the number of contaminants in water that can be chemically oxidized. The COD shows the total amount of oxidizable compounds in the trash (50). The age of the landfill is one of several variables that may affect COD readings. Its high organic matter content's toxicological effects are most likely to blame for the relatively high amounts of COD (41).

N Leachate Post-Spraying Eco-Enzyme

The total N level that continues to increase is thought to occur due to the rapid decomposition process as a result of watering eco-enzymes. The faster the decomposition process of organic matter, the higher the N level. Research on the impact of leachate at the Taman Beringin landfill on the water quality of the Jinjang River in Malaysia in 2020 found that the total N of leachate showed the amount of nitrogen bound in organic matter in the form of ammonia and ammonium (49). The high nitrogen content of ammonia from leachate is the main factor contributing to the growth of algae; it also interferes with biological processing processes, promotes eutrophication, and reduces DO (41). Increase in ammonia nitrogen (NH_4^+-N) and total nitrogen was caused by the biological decomposition of organic N into ammonium N. Temperature affects the biodegradation process of solid waste, due to the optimum temperature that gives the maximum degradation rate (58).

High nitrogen content is common in landfill leachate. Nitrogen is one of the most important nutrients for plants, but its levels that are too high can disrupt the dynamic balance of antioxidant mechanisms, causing the accumulation of reactive oxygen in plant cells (59). The content of nitrogen, carbon, phosphorus, and potassium in leachate makes it possible to utilize and process landfill leachate as an organic fertilizer instead of commercial liquid fertilizer. These existing nutrients are needed to encourage plant growth (60).

Cadmium and Mercury Levels Post-Spraying Eco-Enzyme

The low content of cadmium and mercury is estimated because the type of waste collected in the Suwung landfill is not a type of industrial waste containing heavy metals. In general, the heavy metal content in landfills is relatively low and is still below environmental quality standards (61). Leachate from all forms of solid waste management contains heavy metals (62). Mercury, cadmium, lead, chromium, and arsenic have become the most common heavy metals that cause human poisoning (63). Cadmium is a class of heavy metals that are toxic and harmful to health and the environment if they are in large concentrations (64). Likewise, mercury is a metal that is very toxic to organisms. The health impacts that can be caused include damage to hair and teeth, memory loss, and nervous system disorders (65).

One of the typical properties of heavy metals is that they are not easily biodegradable in the environment (66). The heavy metal content in leachate threatens human health through underground water pollution in the surrounding area (67). Leachate water frequently contains the heavy metals iron (Fe), cadmium (Cd), and zinc (Zn). If used in excess, this metal might have harmful consequences (68). Aeration often isn't as effective as filtering at reducing heavy metals in landfill leachate (61). Leachate from unsanitary landfills has higher concentrations of potentially harmful heavy metals, indicating a large lifelong risk of cancer for adults and children. This is because leachate can build up and spread primarily via the soil in the area into groundwater (69).

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CONCLUSION

Spraying eco-enzymes on garbage piles at the Suwung landfill, Denpasar caused changes in leachate characteristics. The evidence is that the temperature of the leachate becomes high, accompanied by an increase in BOD, COD, TSS, and total N.

An increase in temperature is a hint that spraying eco-enzymes causes microorganisms to grow and carry out decomposition processes. The rapid decomposition process has an impact on increasing the parameters of BOD, COD, TSS, and total N. Results of this study show that environmentally friendly enzymes have the potential to become activators that can be used to accelerate the composting process.

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