

# Potential use of eco-enzyme for the treatment of metal based effluent

**M. Hemalatha and P.Visantini**

School of Biological sciences, Quest International University Perak, 30250, Ipoh, Perak, Malaysia

Email: hemalatha.murugaiah@gmail.com

**Abstract.** Conversion of wastes into value added products is potentially profitable besides creating a clean environment. Eco-enzyme is one such product produced from fermentation of citrus fruit wastes and the effectiveness of the enzyme in treating metal based effluent was investigated. The characteristics of effluent before and after treatment with eco-enzyme were analysed. There was a great reduction in the level of BOD from 80.0 mg/L to 22.3 mg/L. Eco-enzyme also inhibits the growth of microorganisms in the wastewater. These results confirmed that eco enzyme is capable to treat metal based effluent. Besides, sludge treated with eco-enzyme was studied for its potential use in enhancing the growth of chili and aloe vera. Soil containing eco-enzyme treated sludge promotes better growth in chili. Meanwhile, aloe vera grown on soil containing eco-enzyme treated sludge grown almost equally and healthy in comparison with control. This study provides a solution to prevent sludge dumping to ensure clean environment.

## 1. Introduction

In the era of global industrialization, environmental pollution has become critical due to the increase in the worldwide population. This eventually generates more food materials especially fruits, vegetables and cereals to meet the demand. The total production of fruits and vegetables in the world is in increasing trend and at the same time, around 30-40% of the total production is being eliminated as waste due to various reasons [1]. Attempts are being made to protect the environment by recycling the wastes and make use of them for value added applications. Residues of citrus peels can be used for production of various enzymes using fermentation process, where the waste is converted into value-added products [2]. These citrus wastes can be used to produce eco-enzymes by undergoing fermentation process for 3 months after being mixed with brown sugar and water [2]. Eco-enzyme also refers as garbage enzyme is a multi-enzyme solution comprising protease, lipase, and amylase [3]. This enzyme was invented by a researcher in Thailand in the year 2006 by using organic solid waste. Eco-enzyme which is a vinegar-like liquid will be formed after three months of fermentation process using organic solid waste and can serve as a potential solution to treat waste water [4].

Industrialization and innovation have put load on the nature by releasing massive amount of toxic waste such as heavy metals, metalloids and organic contaminants. This caused severe impact on



the nature. Myriad chemical and biological ways are available to treat the industrial waste, yet the problem is not solved due to high cost and longer duration taken to effectively treat the waste. Demand for wastewater treatment plants in industrial and municipal wastewater are increasing rapidly to comply with the allowed limit of wastewater to be discharged in environment [4]. Treating wastewater become a challenging task due to the over production of sludge in industries. Incineration and landfilling are the most common methods which are used to treat sludge [5]. However, the developing nations came up with new laws which force the industries to minimize the amount of sludge to be released to the environment and recommended to contemplate alternative method to reuse the sludge. This study was conducted to treat the industrial effluent rich in metals from electronic industry in Ipoh, Perak by using eco-enzyme which have been produced using citrus fruit peels. Subsequently, potential use of eco-enzyme treated sludge for plant growth was also investigated.

## 2. Materials and Methods

### 2.1. Production of eco-enzyme

Eco - enzyme was produced by adding sugar, citrus waste and water in the ratio of 1:3:10 left to undergo fermentation process for three months [3]. The enzyme produced was filtered and stored at room temperature for further analysis.

### 2.2 Sampling and characterization of industrial effluent

Effluent was collected from electronic based industry (Latitude; 4.6499° N, Longitude; 101.0730° E) in Ipoh and characterized based on these parameters; Biological oxygen demand (BOD), Total solid (TS), Total dissolved solid (TDS), Total suspended solid (TSS), pH, and colony forming unit (C.F.U). BOD of samples was measured using a probe (Fisher Scientific™ accumet™ waterproof AP84 Portable Dissolved Oxygen Meter, Singapore). Evaluation of TS, TDS and TSS of samples were conducted according to Standard Methods published by Public health association, American water works association, water environment federation.

### 2.3 Treatment of effluent using eco-enzyme

Eco-enzyme was used to treat the wastewater and sludge. Treatment was conducted for 5 days. Characteristics of treated wastewater and sludge was analysed based on pH, BOD, TS, TSS, TDS, and C.F.U. to achieve the Standard A water quality set by the United States Environmental Protection Agency (EPA).

### 2.4 Cultivation of plants using eco-enzyme treated sludge

Chili (*Capsicum annuum*) and aloe vera (*Aloe vera*) were used to study the application of eco-enzyme treated sludge for plant growth. Growth medium containing soil treated with eco-enzyme was prepared. Another medium containing soil and eco-enzyme treated sludge in the ratio of 1:1 was also prepared. The physical changes of the plants under treatments were observed and recorded for the period of 10 weeks. Plants were analysed based on height and the condition of the plants. The data was subjected to analysis of variance (ANOVA) and samples means tested for significant differences using statistical analysis (IBM SPSS Statistics 20).

## 3. Results

### 3.1 Characterization of eco-enzyme treated industrial effluent

Eco-enzyme produced after 3 months of fermentation was filtered and used to treat the wastewater collected from metal based industry. Characteristics of effluent before and after treatment with eco-enzyme were analysed and indicated in Table 1. The wastewater was treated with eco-enzyme for the duration of 5 days. It was proven that, eco-enzyme has a promising effect in treating the wastewater as

the reduction in TS, TDS and TSS was observed. Concurrently, the level of BOD significantly ( $P < 0.05$ ) reduced from 80 mg/L to 22.3 mg/L in effluent. Besides, when the wastewater treated with eco-enzyme, there was no bacterial growth observed. Various hydrolytic enzymes present in eco-enzyme increase the accessibility of the enzyme to penetrate the bacterial cell. This will eventually lead to the inhibitory effect against bacterial growth. Besides, eco-enzyme is acidic in nature and lead to the lytic effect of the microorganisms tested [4][6]. Therefore this findings supports the fact that eco-enzyme has antimicrobial property. Overall, eco-enzyme offers an alternative to chemical treatment since EPA standard was met after the treatment using eco-enzyme. Wastewater treatment of eco-enzyme takes longer period of time, but it is safe to be used instead of carcinogenic chemical such as Ethylenediaminetetraacetic acid (EDTA) [7] which in turn could be dangerous to workers who handling it despite affecting the environment.

**Table1** Characteristics of eco-enzyme treated wastewater

Parameters	Effluent	
	Control	After treatment
pH	7.4	7
TS (mg/ml)	464.2	313.5
TDS (mg/ml)	365	221.3
TSS (mg/ml)	97.0	65.0
BOD (mg/L)	80	22.3
c.f.u ml <sup>-1</sup>	$1.5 \times 10^{10}$	0

### 3.2 Study on the potential application of eco-enzyme for plant growth

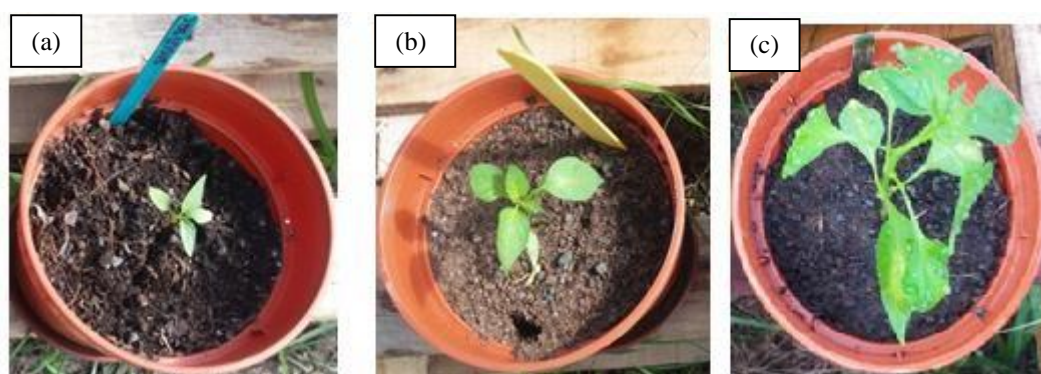
Effect of eco-enzyme in stimulating plant growth using sludge was investigated. Sludge which was treated with 25% of eco-enzyme used to grow chili and aloe vera for the duration of 10 weeks. Eco-enzyme was diluted prior to use as concentrated eco-enzyme can cause the soil to become acidic which eventually affects the growth of plants [8]. It was observed that the soil containing eco-enzyme treated sludge significantly ( $P < 0.05$ ) promote growth of chili plant in comparison with the medium containing only soil and soil with eco-enzyme (Table 2). The height of chili plant on week 10 was  $12.8 \pm 1.1$  cm. Meanwhile, the height of control was only  $2.9 \pm 0.19$  cm. The conditions of the chili plants after 10 weeks of growth are indicated in Figure 1. Sludge is rich with organic matter and other nutrients [9]. This is a possible reason, when soil with eco-enzyme treated sludge was used; significantly higher growth was recorded in chili plant.

Table 3 shows the length of aloe vera under various growth medium. There were no significant changes in the length of leave in aloe vera grown for the duration of 10 weeks. Interestingly, growth medium containing sludge did not suppress the growth of aloe vera. The plant grown on soil treated with eco-enzyme and soil treated with eco-enzyme treated sludge comparatively show healthier growth than control on week 10 (Figure 2). Eco-enzyme containing multiple hydrolytic enzymes may have significant effect in maintaining soil health [10] which eventually promotes the growth of chili and aloe vera. These promising results offer an alternative to utilize the sludge for agriculture and eventually offer a solution to reuse the sludge in waste water treatment. These findings also propose a solution to the issue of sludge dumping for sustainable environment.

**Table 2** Effect of eco-enzyme on the growth of chili under various medium

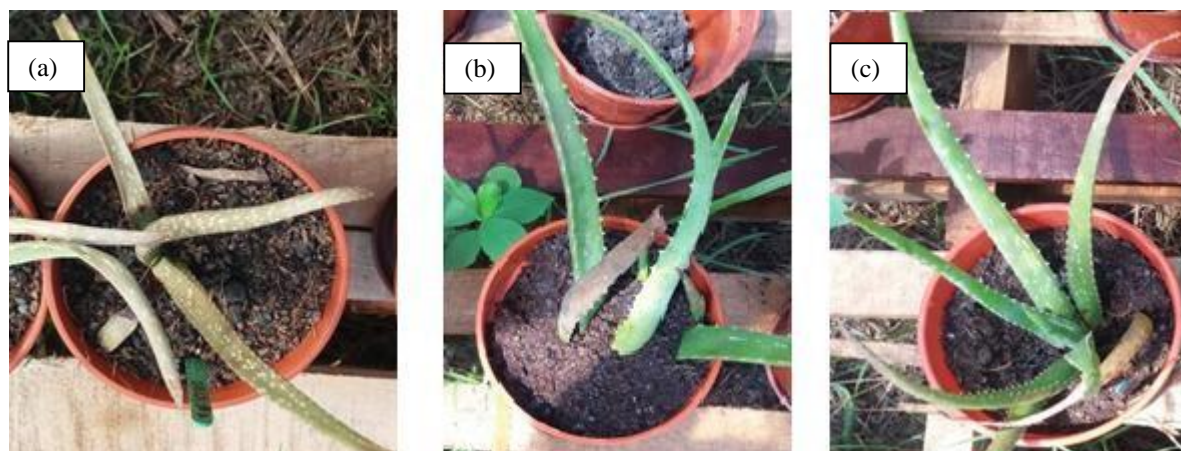
Duration (weeks)	Height of plant (cm)		
	Soil (Control)	Soil treated with eco-enzyme	Soil with eco-enzyme treated sludge
2	2.30±0.1 <sup>a</sup>	3.60±0.1 <sup>b</sup>	4.20±0.2 <sup>c</sup>
4	2.50±0.1 <sup>a</sup>	4.20±0.2 <sup>b</sup>	5.50±0.2 <sup>c</sup>
6	2.50±0.2 <sup>a</sup>	4.50±0.2 <sup>b</sup>	7.40±0.4 <sup>c</sup>
8	2.80±0.2 <sup>a</sup>	4.70±0.2 <sup>b</sup>	9.50±0.3 <sup>c</sup>
10	2.90±0.2 <sup>a</sup>	5.00±0.2 <sup>b</sup>	12.8±1.1 <sup>c</sup>

\*Values are mean±standard deviation triplicates. Mean with different superscript (a,b,c) within the same column are significantly different at p<0.05

**Figure 1** Condition of chili plant on week 10 in growth medium containing (a) Soil (Control), (b) Soil treated with eco-enzyme, (c) Soil with eco-enzyme treated sludge**Table 3** Effect of eco-enzyme on the growth of aloe vera under various medium

Duration (weeks)	Height of plant (cm)		
	Soil (Control)	Soil treated with eco-enzyme	Soil with eco-enzyme treated sludge
2	15.1±0.2 <sup>a</sup>	15.2±0.2 <sup>a</sup>	15.3±0.3 <sup>a</sup>
4	15.5±0.3 <sup>a</sup>	16.0±0.2 <sup>a</sup>	16.3±0.4 <sup>a</sup>
6	16.0±0.5 <sup>a</sup>	17.0±0.5 <sup>a</sup>	17.2±0.4 <sup>a</sup>
8	16.5±0.4 <sup>a</sup>	17.8±0.3 <sup>a</sup>	18.0±0.5 <sup>a</sup>
10	17.2±0.7 <sup>a</sup>	18.6±0.5 <sup>a</sup>	19.0±0.6 <sup>a</sup>

\*Values are mean±standard deviation triplicates. Mean with different superscript (a,b,c) within the same column are significantly different at p<0.05



**Figure 2** Condition of aloe vera on week 10 in growth medium containing (a) Soil (Control), (b) Soil treated with eco-enzyme, (c) Soil with eco-enzyme treated sludge

## Conclusion

In the present study eco-enzyme produced using citrus fruit waste offer potential solution to treat waste water in eco-friendly way. About 70% reduction in the level of BOD from metal based effluent was observed. Effectiveness of eco-enzyme in treating waste water was proven based on the reduction obtained for TS (32.5%), TDS (39.5%) and TSS (33.0%). It is suggested that eco-enzyme can also inhibit the growth of microbes which was proven based on the C.F.U value obtained. Study on the applications of eco-enzyme to improve soil fertility reveals that chili and aloe vera showed improved growth in the duration of observation (10 weeks). Chili showed significant growth when the growth medium containing soil and sludge treated with eco-enzyme was used. Aloe vera showed a promising growth in the presence of eco-enzyme compared to control which contain only soil. This results prove that eco-enzyme improve the fertility of the soil. Besides, when the sludge treated with eco-enzyme, enhanced growth of chili and aloe vera were also recorded. Although it need further study on the mechanism of the eco-enzyme in treating waste water, this research offer a potential solution to treat metal based effluent and suggest a prospective use of sludge in agriculture for sustainable environment.

## References

- [1] Pleissner D and Lin C S K 2013 Valorisation of food waste in biotechnological processes *Sustainable Chem Processes* **1**(1) 21-6.
- [2] Arun C and Sivasanmugam P 2017 Study on optimization of process parameters for enhancing the multi-hydrolytic enzyme activity in garbage enzyme produced from preconsumer organic waste *Biores Tech* **226** 200-10
- [3] Tang FE and Tong CW 2011 A study of the garbage enzyme's effects in domestic waste water *World Academy of Eng and Tech* **60** 1143-48
- [4] Arun C and Sivasanmugam P 2015 Investigation of biocatalytic potential of garbage enzyme and its influence on stabilization of industrial waste activated sludge *Process Safety and Environ Protec* **9** 471-8
- [5] Gaur N Flora G Yadav M and Tiwari A 2014 A review with recent advancements on bioremediation-based abolition of heavy metals *Environ Sci: Processes & Impacts* **16**(2) 180-93
- [6] Straub TM, Pepper IL and Gerba GP 1993 Hazards from pathogenic micro-organisms in land-disposed sewage sludge *Rev of Environ Contam and Toxic* **132** 55-91
- [7] Awaleh MO and Soubaneh YD 2014 Waste water treatment in chemical industries: The concept and current technologies *Hydrology Curr Res* **5**(1)
- [8] Marschner B and Noble A D 2000 Chemical and biological process leading to the neutralisation of

- acidity in soil incubated with litter materials *Soil Bio and Biochem* **32** 805-13
- [9] Tao J, Wu S, Sun L, Tan X, Yu S, Zhang Z 2012 Composition of waste sludge from municipal wastewater treatment plant *Procedia Environ Sci* **12** 964-971
- [10] Das SK and Varma A 2011 *Soil Enzymology* Springer-Verlag Berlin Heidelberg