

The Effect of Express Microorganisms (EM4) on Chemical Compounds in Liquid Wastes of Oil Palm

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Abstract: High content of chemical compounds of palm oil mill effluent is potential as source of organic fertilizer that beneficial for plant growth. The aim of this study was to investigate the effect of express microorganisms-4 (EM-4) in reducing the chemical characteristics such as nitrogen (N), phosphorus (P), potassium (K) and chemical oxygen demand (COD) of palm oil mill effluent. The effluent was obtained from end process of crude palm oil (CPO) at oil palm plant at North Sumatera. Several concentrations of EM-4 (1, 3, 5, 7, and 9 mL) were mixed in 200 mL graduate cylinder to the effluent 99, 97, 95, 93 and 91 mL respectively. All suspensions were mixed homogeneously and were incubated anaerobically at 29°C for 5, 10 and 15 days. All treatments were replicated 3 times. Results showed that express microorganisms-4 is effective in reducing chemical characteristics of the palm oil mill effluent such as nitrogen, phosphorus, potassium and chemical oxygen demand. In general, the highest EM-4 concentration is followed by the lowest of the chemical characteristics.

1 INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is one of the most export commodity in Indonesia. During the processing of the fresh fruit bunch to become crude palm oil (CPO), high quantity of the by products, solid and liquid wastes were produced. Non-processed of the effluent has negative effects on environment (Singh and Pandey 2009; Wu et al. 2010).

Therefore, treatment of palm oil mill effluent were required to decompose from complex compounds into derivative products such as methane for fuel and simple macro and micro nutrients that can be used as liquid fertilizer for plants growth. There are many indigenous microorganisms presence in palm oil mill effluent such as *Micrococcus luteus*, *Stenotrophomonas maltophilia*, *Bacillus cereus*, *Klebsiella* (Bala et al. 2018), Soleimaninanadegani and and Manshad (2014) used local microorganisms in degrading palm oil mill effluent and indigenous microorganisms in the effluent are more effective than introduce microorganism.

Aerobic and anaerobic microorganisms have important role in accelerate decomposition process.

In nature, the activity of microorganisms in decomposing liquid waste reduce chemical oxygen demand (COD) (Nwuche et al. 2014). Effective microorganisms (EM) is liquid substance that contain mixed cultures (microbial consortium) of fermentative living microorganisms (bacteria, mold and yeast that advantage and work synergically in degrading organic compounds (Britton 1984).. The purpose of the recent study was to investigate the effect of fermentation of palm oil mill effluent by EM-4 on the amount of macronutrients (nitrogen, phosphorus, potassium and chemical oxygen demand).

2 MATERIALS AND METHOD

2.1 Preparation of Palm Oil Mill Effluent

The research was conducted on Research Center of oil Palm and Microbiology and Biotechnology Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara. The effluent of oil palm was obtained from processing end of oil

palm plant at PTPN IV Adolina, Perbaungan, North Sumatera. As much as 2 L of the liquid waste was suspended and the supernatant in 200 mL graduate cylinder was mixed with effective microorganisms (EM-4) as follows: 1 mL EM+99 mL; 3 mL EM+97 mL; 5 mL EM+ 95 mL; 7 mL EM+93 mL; 9 mL EM+91 mL and 100 mL supernatant with no EM used as control. All treatments were mixed homogenously and incubated anaerobically at 29°C for 5, 10 and 15 days. Three replications were made for each treatment.

2.2 Determination of N, P, K, and COD

Analysis of nitrogen (N), phosphorus (P), potassium (K) and chemical oxygen demand (COD) was conducted before and after treatment by EM-4. The percentage of nitrogen compound was observed by Kjehdal method. Whereas, phosphorus (%), potassium (%) and chemical oxygen demand (mg/L) were observed according to the procedure Standard Methods for Examination of Water and Wastewater, American Public Health Association (APHA) (1998).

3 RESULTS AND DISCUSSION

3.1 pH and Concentration of N, P, K, and COD in Liquid Waste of Oil Palm

The initial pH of palm oil mill effluent observed was 4.10 and concentration of nitrogen, phosphorus, potassium an COD of liquid waste oil palm before fermented by EM-4 was shown in Table 1.

Table 1: Chemical characteristics of palm oil mill effluent before treated by EM-4

Sample number	Chemical characteristics of effluent			
	N (%)	P (%)	K (%)	COD (mg/L)
1	3.53.	7.32.	6.50	305.12
2	5.04	5.90	5.31	270.80
3	3.89	6.04	8.91	336.41

Among nitrogen and potassium, phosphorus was the highest component in the effluent, however, all chemical characteristics still above standar. The concentration of nitrogen in palm oil mill effluent after fermented by EM-4 reduce in compare to control tretments (Table 2).

Table 2: The effect of EM-4 concentration on nitrogen compounds n liquid waste of oil palm

EM-4 concentration (%)	days / nitrogen concentration (%)		
	5	10	15
0 (control)	5.42	6.76	6.37
1	1.26	2.23	0.48
3	1.26	1.16	0.35
5	0.18	3.08	0.29
7	0.25	4.09	0.85
9	0.62	5.39	1.09

In general, EM-4 affect on reducing nitrogen, phosphorus, potassium content and COD. The consortium of microorganism in EM-4 indicate the microorganisms work synergically by releasing hydrolytic enzymes in degrading organic molecules (Britton 1984; Boopathy 2000). The highest reducing nitrogen occurred at EM-4 5% after 5 days of incubation, however, the N concentration increased sharply at 9% EM-4 concentration after 10 to 15 days of incubation. We assumed that the consortium of microorganisms in EM-4 begin to grow and degraded protein compounds.

The effect of EM-4 activity on phosphorus in the effluent showed the increasing of EM-4 and length of fermentation was followed by the reducing of phosphorus (Table 3). Similar to nitrogen, the presence of EM-4 reduce phosphorus content drastically. The lowest P occurred on 9% EM-4 particularly after 15 days of incubation.

Table 3: The effect of EM-4 concentration on phosphorus compounds in palm oil mill effluent

EM-4 concentration (%)	days /phosphorus concentration (%)		
	5	10	15
0 (control)	7.39	7.08	7.39
1	1.26	2.47	0.24
3	0.67	0.55	5.45
5	0.60	1.30	4.35
7	0.79	0.54	1.07
9	0.62	0.27	0.21

As shown in Table 1 and Table 3, phosphorus was the highest compound in the effluent, it might EM-4 reduce the compound during fermentation. Similat to the concentration of nitrogen and phosphorus, the effect of EM-4 also reduce potassium (Table 4).

Table 4: The effect of EM-4 concentration on potassium compounds in palm oil mill effluent

EM-4 concentration (%)	days / phosphorus concentration (%)		
	5	10	15
0 (control)	7.31	7.51	7.38
1	5.61	14.09	4.88
3	4.47	12.54	4.37
5	3.91	11.3	3.99
7	2.49	11.6	4.53
9	1.64	1.69	4.06

In compare to control treatments, the potassium was drastically reduced by the presence of EM-4. The higher EM-4 concentration is followed by lower potassium. The presence of microorganisms in EM-4 in the effluent reduce chemical oxygen demand (COD) (Table 5).

Table 5: The effect of EM-4 concentration on chemical oxygen demand (COD) in palm oil mill effluent

EM-4 concentration (%)	days / chemical oxygen demand (COD) (ppm)		
	5	10	15
0 (control)	364.46	384.95	385.08
1	205.61	111.35	164.90
3	193.51	122.99	141.63
5	168.94	136.42	104.69
7	89.30	140.37	123.37
9	102.04	128.22	147.13

In general, the effect of EM-4 reduced COD and the final pH was 4.82 (no shown in table). It can be seen that EM-4 at concentration 7 and 9% lowering COD after 5 to 15 days of incubation, which was similar to the results reported by Poh and Chong (2009), might due to the organic substances were decompose by microorganism to obtain simple molecules for their grow. Fungi and bacteria that high hydrolytic enzymes is potential in degrading cellulose and lipid content in the effluent (Sethi et al. 2013).

4 CONCLUSION

The presence of express microorganisms (EM-4) during anaerobic is potential in reducing chemical composition and chemical oxygen demand of palm oil mill effluent.

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