WASTE MANAGEMENT IN THE PALM OIL INDUSTRY: A CASE STUDY OF CO-COMPOSTING OF OIL PALM EMPTY FRUIT BUNCHES AND DECANTER CAKE SLURRY

[1]NUTTHATUS CHERYPIEW, [2]THUNWADEE TACHAPATTAWORAKUL SUKSAROJ

[1]Environmental Management Program, Faculty of Environmental Management, Prince of Songkla University. Songkla 90112, Thailand.
[2]Pitak Palm Oil Co., Ltd., 99 Moo3, Kalasae Sub district, Sikao District, Trang 92150, Thailand.
E-mail: Nutthatus_pto@hotmail.com, tthunwad@yahoo.com

Abstract- When oil palm empty fruit bunch (EFB), waste from palm oil process contains oil that could impact on the environment when it was dumped on land, the EFB pressing was applied in the manufacturing process in order to recover oil and the EFB compost may be enhanced in the same time. Therefore this study aimed to investigate the effect of pressing on the EFB composting efficiencies in comparing with non-pressed EFB. The decanter cake was used as nitrogen supplement for composting. The initial C: N ratio was varied at 35: 1, 40: 1 and 45: 1 to study the optimal mixing ratio of composting materials. The experiment was done in pilot scale in the factory area. The result was found that the C:N ratio of both Pressed EFB and Non-Pressed EFB was decreased to be lower that 20:1 since before 15th day while the control of compost experiment cannot be terminated at 30th day. The nutrients element in compost products met the standard of compost product. While the composting time and product quality were not different between pressed and non-pressed EFB composting but the addition of EFB pressing step into palm oil process could recover oil by 1.22 % of oil content in EFB. The mixing ratio of pressed or non-pressed EFB and decanter cake was optimized at 45:1.

Keywords- Composting, Palm Oil Empty Fruit Bunches (EFB), Decanter Cake Slurry

I. INTRODUCTION

In the past 10 years, the area of oil palm plantation and palm oil factory had been increased over 100 percent. Oil palm products from oil palm gardens are sent to crude palm oil process. The process crude palm oil production generates several wastes such as wastewater, palm fiber, shell, decanter cake and empty fruit bunch. The wastewater or palm oil mill effluent (POME) is used to produce biogas, for use as a fuel of power engine machines. Shell and fiber are burned in boilers, produce heat and electricity. Oil palm empty fruit bunches and decanter cake was used for composting, land covering or dumping in oil palm gardens. But these contribute some problems to the surrounding environment. The oil palm empty fruit bunches and decanter cake still contains oil that can be leached by rain discharged into the nearby water source. In addition this dumping can be the habitat of poisonous animals. The oil palm empty fruit bunch is difficulty biodegradation material (Astimar and Wahid, 2006) the natural composting requires more than 90 days for its degradation. Because of the requirement of pail oil mill waste management that has high waste quantities especially the oil palm empty fruit bunches and palm oil decanter cake, these waste were continuously investigated for their utilization. Many studies were found that oil palm empty fruit bunches and decanter cake can be used to produce composting, it contains nutrients such as nitrogen, phosphorus and potassium, which are essential nutrients for plants (Azmi Yahya et al., 2010). Currently, some oil mill chose the process of oil palm empty fruit bunch compression added into the process in order to recovery oil in this waste. This alternative process could give higher yield eventhough the oil recovered is reduced its quality but it increases income to the manufacturer. In addition, it make a smaller size, lower moisture, lower oil content of empty fruit bunch waste when comparing with non-pressed one. Therefore this study was interested to investigate the composting efficiencies interm of composting duration and compost product qualities in comparing between the composting used pressed and non-pressed oil palm empty fruit bunch as the material and decanter cake was used as a supplemental nitrogen source.

II. MATERIALS AND METHODS

I. Composting substrates
Fresh oil palm empty fruit bunches, pressed one and decanter cake sludge were given by Pitak Palm Oil Company Limited, locates Kalase sub-district, Trang, Thailand. The EFB was cut into small pieces (5-10 cm) by machine. The characteristics of the composting materials were presented in Figure 1.

II. Composting microbes
The super PD 1, selected composting microorganisms produced by Department of Agriculture, Ministry of Agriculture, Thailand was used to enhance composting efficiency. It contains several groups of effective microorganisms that are suitable for the agricultural wastes degradation. It has ability to digest cellulose, a major component of the compost material,

degrade oils and fat components. It can withstand in high temperature condition, and can produce spore by itself when it is stored for a long time. The freezing dries form was re-suspended in tap water and was rest for 24 hours before use.

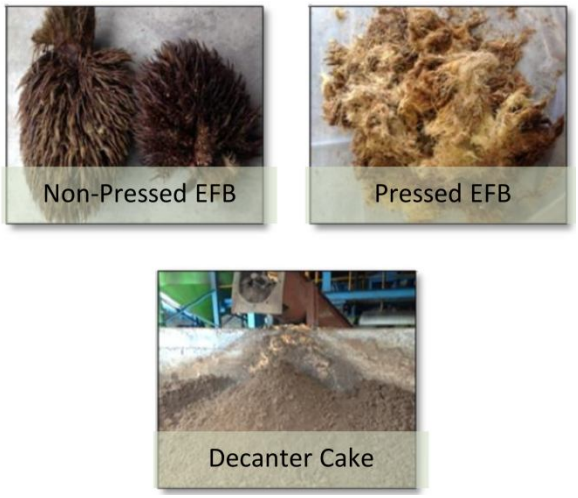


Figure 1 Composting substrates

III. METHODOLOGY

I. Analysis of compost materials components
The chemical characteristics of composting materials were analyzed to determine the C: N Ratio and set up the piles. The moisture, pH, organic carbon, organic matter, total nitrogen, phosphorus, and potassium were also analyzed to monitor the piles and investigate the compost product quality.

II. Experimental Design
The different conditions were designed and set up to investigate the effect of empty fruit bunch pressing on the composting efficiencies. This study consists of 2 experiments and each experiment had 4 conditions, each condition was done in duplicate.

Experiment 1 consisted of;
CNP control (empty fruit bunches non-pressed).
NP1 oil palm empty fruit bunches non-pressed and sludge decanter. Designated C / N Ratio 35: 1
NP2 oil palm empty fruit bunches non-pressed and sludge decanter. Designated C / N Ratio 40: 1
NP3 oil palm empty fruit bunches non-pressed and sludge decanter. Designated C / N Ratio 45: 1.

Experiment 2 consisted of;
CEP control (empty fruit bunches pressed).
EP1 oil palm empty fruit bunches pressed and sludge decanter. Designated C / N Ratio 35: 1
EP2 oil palm empty fruit bunches pressed and sludge decanter. Designated C / N Ratio 40: 1
EP3 oil palm empty fruit bunches pressed and sludge decanter. Designated C / N Ratio 45: 1
The composting pile was done in rectangular concrete groove, 80 x160x60 cm3 (width x long x height) or it has a total volume of 0.768 m3. The compost pile was aerated by compressed air. The weight of composting materials in each pile was 120 kg.

III. Analysis of compost pile during the composting process During the composting process, it analyzes various parameters to use as a comparison and the percentage change in the fermentation process. Analyzed of moisture, pH, organic matter, organic, carbon, total nitrogen, phosphorus, potassium, carbon to nitrogen ratio.

IV. Composting efficiencies determination
The compost product could be used as soil supplement or used as a fertilizer for the plants, there is a great need to evaluate the quality compost obtained.

The compost product was analyzed the parameters in according with Thailand compost standard (Department of Agriculture, 2005). the composting efficiencies, composting duration and compost quality, were compared within the experiment and between experiments.

IV. RESULTS AND DISCUSSION

I. Empty Fruit Bunches (EFB) and decanter cake characteristics
The results of the EFB and decanter cake analysis are shown in Table 1. The nitrogen content of the decanter cake slurry is much greater than those of the EFB. The EFB pressing allows nitrogen increased, resulting in a C: N ratio decreased.

But on the other hand, would result in a decrease of potassium in the EFB. The calculated C/N ratio for EFB, EFB pressed and decanter cake slurry was 71.62, 59.34 and 18.69, respectively.

Table 1 the characteristics of non-pressed, pressed empty fruit bunches and decanter cake.

Analysis	Non-pressed EFB	Pressed EFB	Decanter Cake Slurry
pH	6.19	6.97	5.25
Moisture	52.74	36.00	51.72
Organic Carbon	44.38	41.33	42.55
Organic Matter	76.52	71.26	73.63
Total N	0.62	0.70	2.28
C/N ratio	71.62:1	59.34:1	18.69:1
Total P_2O_5	0.02	0.03	0.08
Total K_2O	0.82	0.67	0.36

II. Determining proportion of the material (C: N ratio)
The results from Table 1 can be used to calculate the mixing ratio of substrated in order to set the initial C:N ratio at 35: 1 40: 1 and 45: 1 respectively (Tchobanoglous, 1993).

The results of the calculation are shown in the Table 2.

Table 2 The proportion of the materials set for designed initial C: N ratio.

Materials of 120 kg		C:N ratio		
		35:1	40:1	45:1
Experiment 1	EFB (Kg.)	74.53	85.71	94.49
	Decanter Cake (kg.)	45.47	34.29	25.51
Experiment 2	EFB Pressed (kg.)	82.76	94.49	103.45
	Decanter cake (kg.)	37.24	25.51	16.55

III. Temperature distributions of compost piles with time Analysis of Variance for the temperature of the compost with respect to time (day) was carried out. The temperature was measured at depth of 30 cm. and 8 point covers the pile and the temperature checking was done every day at 9.30 am. It was found that the temperature of pile increased since the first day and reached the highest temperature on third day of composting. The temperature of EP1, 2 and 3 on that day were 67.42, 68.12 and 64.44 respectively. For Non-Pressed EFB composting or NP experiments, it was found that the highest temperature of piles was a few lower than EP piles, they were 58.10, 59.70 and 60.20 oC for NP1, NP2 and NP3 respectively. It may be suspected that the microbes can digest the compost materials in the experiments of pressed EFB better than non-Pressed EFB. The temperature is gradually reduced until it was close to ambient temperature. At the 30th day, the temperature of EP1, EP2 and EP3 decreased to 37.20, 38.18 and 36.30 respectively whereas the temperature of NP1, NP2 and NP3 were 36.6, 36.20 and 3.10 respectively. The temperature profiles of experimental piles were presented in in Figure 2.

Temperature distributions

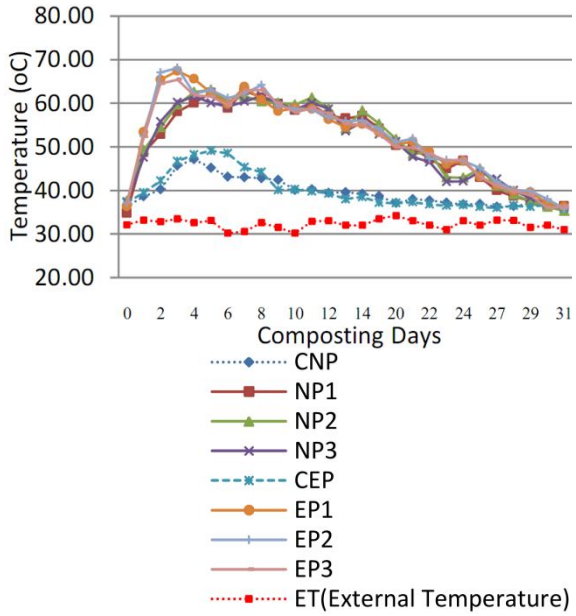


Figure 2 Temperature of compost piles with time

IV. pH distributions of compost piles with time
The initial pH of pressed EFB, EP1, EP2 and EP3 were 6.55, 6.58, and 6.82, and non-Pressed EFB, NP1, NP2 and NP3 were 6.75, 6.68 and 7.10, respectively.

During composting, the pH of all piles slightly augmented. On the 7th day, the pH of EP1, 2, and 3 increased to be 9.32, 9.25 and 9.30 while the pH of NP1, NP2 and NP3 were 9.30, 9.60 and 9.40, respectively, which is the highest pH value throughout the composing duration.

After that their pH reduced to be 8.42, 8.43 and 8.47 for EP1, 2, and 3 and 8.35, 8.62 and 8.54 for NP1, 2 and 3 respectively, which were lower than that of control (9.27 of CEP and 9.21 of CNP).The increase of pH in the compost as a result of bacterial degradation.

Become a component of amino acids. The amino acid is decomposed to become, Fatty acids and ammonia (NH3) or ammonium ions (NH4+) by the ammonification (Delaune et al., 2004). The pH of the compost pile will gradually decrease, because microorganisms nitrifying bacteria transformed ammonia or ammonium ions, to nitrite (NO2) and nitrate (NO3), respectively, by the Nitrification, and with the release of hydrogen ions (H+) from the acidic (Eklind and Kirchmann, 2000).The pH change is shown in Figure 3. pH distributions

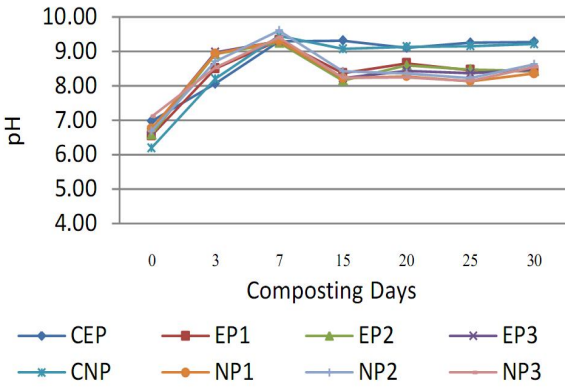


Figure 3 pH distributions of compost piles with time

V. Organic matter distributions of compost piles with time The organic matter content of compost materials of all piles was decreased along the period of composting (Kulcu and Yaldiz, 2004) because of biodegradation occurred. However until the composting termination on 30th day, the organic matter content of compost product of all piles still exceed 30%.

The standards of the organic matter in the compost product must not be lower than 30 percent (Department of Agriculture, 2005). On the 30th day, the organic matter of pressed EFB compost (EP1, 2 and 3) were 58.4, 62.93 and 65.58 percent and non-pressed EFB compost obtained were 56.37, 58.45 and 58.59 percent for NP1, 2 and 3 respectively.

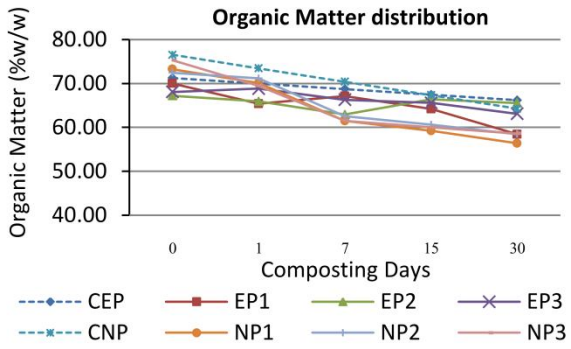


Figure 4 Organic matter distributions of compost materials with time.

VI. C: N ratio distributions of compost piles with time
When the C: N ratio of any compost material in the pile is less than or equal to 20: 1, the compost is complete (Samudro and HerMana, 2007). In this study the initial C: N ratios were set at 35: 1, 40: 1 and 45: 1. The results showed that the composting can be terminated within 15th day of composting because their C:N ratios measured were lower than 20:1. The final C:N ratios of all piles were in range of 10.01-14.68. It was found that ther in not the difference between EP and NP piles.

C:Nratio distributions

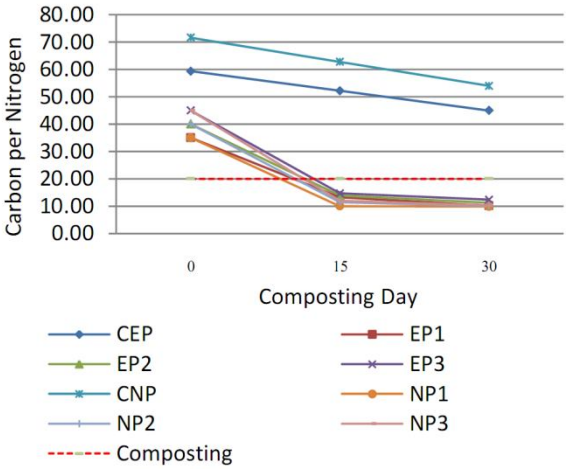


Figure 5 C: N ratio distributions of compost materials with time

VII. Final chemical compositions of the matured compost (30th Day)
The completed compost was set the requirement of macronutrients, nitrogen is not less than 1%, phosphorus is not less than 0.5%, and potassium is not less than 0.5% by weight, the organic matter content has not less than 30 percent by weight, the temperature inside the compost pile has to be equivalent or close to the outside temperature, the odor or smells should be like soil naturally. The C: N ratio has to be less than 20: 1. The nitrogen content in compost product from EP piles (EP1, EP2 and EP3) and NP piles NP1, 2 and 3) were 2.76, 2.82, 2.53, 3.43, 2.88 and 2.84 percent by weight respectively which met the requirement of compost standard (1% as minimal). The phosphorus contents in compost product obtained from the piles in the 30th day of composting were also greater than the control and that standard required (0.41 and 0.5 percent by weight). The NP compost yielded higher phosphorus content than that of EF compost product that may be the result of EFB pressing. The potassium content was also met the requirement of standard (0.5% by weight as minimal). When consider all macronutrients requirement, the compost products from our experiment can be used as fertilizer. The compost product composition was presented in Table 3.

Table 3 Final chemical compositions of the matured Compost

Element	Pressed EFB+ Decanter cake				Non-Pressed EFB + Decanter cake			
	CNP	NP1	NP2	NP3	CEP	EP1	EP2	EP3
Nitrogen	1.73	2.76	2.82	2.53	2.21	3.43	2.88	2.84
Phosphorus	0.46	0.63	0.59	0.63	0.41	0.54	0.56	0.54
Potassium	3.61	3.94	3.90	3.99	3.15	3.65	3.78	4.04
Organic Matter	**64.26**	64.20	66.37	65.58	66.17	59.20	60.61	60.02
C:N ratio	45.0	10.13	11.21	12.34	54.0	9.85	10.12	10.32

CONCLUSIONS

The addition of EFB pressing into palm oil process gave the benefit to the manufacturer by the higher production yield that obtains from oil recovery and it did not effect on compost product quality. The result showed the EFB pressing did not impact on the compost duration and compost product quality. The variation of initial C:N ratio from 35:1 to 45:1 did not influence on composting efficiencies also. When consider the substrates mixing ratio in order to manage high quantity waste like EFB, the C: N ratio of 45:1 would be optimal for application.

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