RAPID COMPOSTING OF EMPTY FRUIT BUNCH USING EFFECTIVE MICROBES

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Rapid composting of accumulated empty fruit bunch (EFB) at palm oil mills is crucial to make composting viable and effective. Many technologies have been developed for rapid composting, but the main challenge is the economic feasibility, mainly caused by the cost of the effective microbes. Therefore, the developed formulation of microbial consortia was isolated with the target to accelerate the degradation of the EFB biomass through specific enzyme activities.

NOVELTY

The laboratory scale experiment, showed that the combinations of enzymes from *Bacillus substilis* (CPO1) and *Bacillus cereus* (AA8) such as cellulase, ligninase, amylase and protease; were able to enhance the rapid degradation of EFB under aerobic condition.

MICROBIAL INOCULATION ONTO EFB FOR COMPOSTING PROCESS

The EFB was sterilised by using autoclave for 30 min at 121°C in big autoclave plastic bag (500 x 750 mm). For single microbial inoculation, the submerged culture inoculum was poured onto the sterilised EFB which was 40% of the EFB weight (v/w). Then sterilised water (50% of EFB weight (v/w) was added and the mixture was mixed and shaken to homogenise the cell culture on the EFB. The colony-forming unit (CFU), oils, lignin, cellulase content and C:N ratios were analysed daily for the 28th days.

For the bio-consortia inoculation, the EFB was composted for 24 days with combination of CPO1 and AA8 as bio consortia using different inoculum ratio; (Ratio 1; CPO1 1: AA8 1, Ratio 2; CPO1 2: AA8 1, Ratio 3; CPO1 1: AA8 2). The composted EFB with single inoculation of AA8 and CPO (*Figure 1*) at 1.0 x 10^{12} was used as inoculum and was formulated for each ratio and was added to the sterilised EFB at 40% w/w. Sterilised water (50% of EFB weight (v/w)) was also added and the EFB mixture was daily shaken and stirred to provide an aeration to ensure uniform distribution of the microbe on the EFB. The sample was analysed every three days during the composting process.

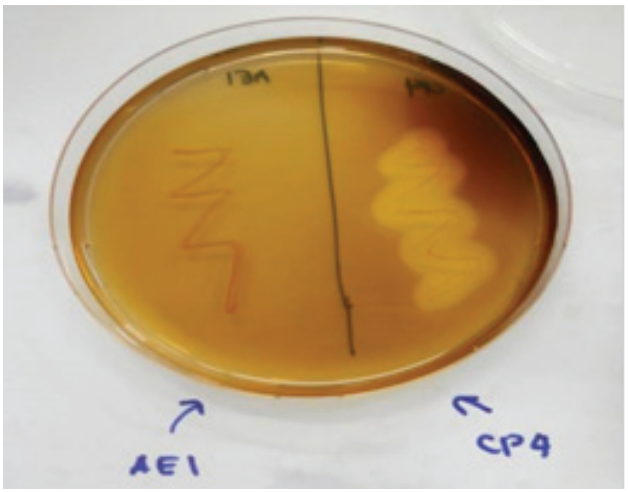

Figure 1. Results of cellulase test for Bacillus substilis *strains. The clear zone shows the breakdown of CMC (positive cellulose).*

The oil degradation percentage, lignin and cellulose content of the prepared composts from the combination of two isolated strains are presented in *Table 1*. Over 25 days of composting, the *Bacillus substilis* (CPO1) and *Bacillus cereus* (AA8) combination showed the highest oil degradation and cellulose contents with the reduction of 84.21% and 31.65%, respectively. The strain combination was carried out at a ratio of 1:1.

This composting study using *Bacillus substilis* (CPO1) and *Bacillus cereus* (AA8) were found to reach the lowest values for C: N ratio with the values of 17 and 18.8 in day 25 as compared to other studies (*Table 2*). Nagasaki *et al.* (1992) have proposed that the desirable C: N ratio for composting should be within the range of 16 to 21. This type of compost is very suitable for the agriculture sector.

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TABLE 1. DEGRADATION PROPERTIES OF EFB BY STRAINS COMBINATION, READING WAS TAKEN AT DAY 28 OF COMPOSTING

Strains	% oil degradation	% lignin degradation	% cellulose degradation
Bacillus substilis (CPO1) + *Bacillus cereus* (AA8)	84.21	24.72	31.65

TABLE 2. COMPARISON OF C: N RATIO OF DIFFERENT COMPOSTS DURING THE COMPOSTING PROCESS

Material/microorganism	C: N ratio	Composting duration (day)	References
EFB + fresh POME	15	40	Schuchardt *et al*. (2000)
Different combination and ratio of oil palm frond compost + chicken manure + rice bran	21.34	21	Erwan Ismail *et al.* (2012)
Selected substrates + POME + EFB +Wheat flour + *P. chrysosporium* + *T. harzianum* + *A. niger*	17	60	Kabbashi *et al*. (2006)
Olive pomace + *P. chrysosporium* + *T. harzianum*	59.30	50	Haddadin *et al*. (2009)
EFB + *Trichoderma* sp.	3.33	105	Siddiquee *et al.* (2017)
EFB + *Bacillus substilis*	17	25	This study
EFB + *Bacillus cereus*	18.8	25	This study

BENEFITS

Table 2 shows the comparison of C:N ratio of different materials of compost during the composting process of other studies with this study. This study found that the C:N ratio value was lower at the short composting time as compared with other studies that took about 20-100 days to make compost mature. The microbial inoculated compost was likely to speed up the composting process of EFB to 25 days. The inoculation of microbial into EFB compost can improve the efficiency of EFB decomposition.

ECONOMIC FEASIBILITY

The estimated fixed cost for the production of compost from EFB is RM 2 250 000 which is based on the capacity of 83 t month^{-1}.

TABLE 3. ECONOMIC ANALYSIS OF COMPOST PRODUCTION USING EFFECTIVE MICROBES

Economic analysis	Value
Net present value (NPV)	RM 7 590 068
Internal rate of return (IRR)	48.90%
Payback period	3.2 yr
Benefit cost ratio (B:C)	2.11

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