SMALL-SCALE PRODUCTION OF PALM-BASED VERMICOMPOST

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The vermicomposting process has been described as the bio-oxidation and stabilisation of organic material involving the joint actions of earthworms and (mesophilic) microorganisms (Aira *et al.*, 2002). In contrast to traditional compost, vermicompost never heats up much above the ambient temperature. Many practitioners combine the two techniques, initially doing a partial pre-composting at high temperatures, followed by a finishing stage of vermicomposting (Frederickson, 1997). Vermicompost from earthworm fecal pellets, or casts, are different from traditional compost because the casts are covered with a mucus layer secreted by the worms' intestinal tract. Several recent studies have investigated the effect that the polysaccharides of earthworm origin may have on the physical aspects of soil, as well as the documented effects on soil microbiota.

In a previous study conducted by MPOB, the vermicomposting of oil palm biomass using the African Nightcrawler, *Eudrilus eugeniae*, has been investigated to select the best fibre for the process, and also to examine its degradation effects on the lignocellulosic component (cellulose and lignin) of the biomass. The trials have demonstrated that empty fruit bunches (EFB) are the best substrate for vermicomposting, as compared with oil palm trunks (OPT) and oil palm fronds (OPF), and that the cellulose component is the most degraded portion as a result of vermicomposting. The C:N ratio decreased with time in all the vermireactors, indicating a stabilisation of the vermicomposting process (*Table 1*). There was an increase in pH and a shift towards neutrality for all the feed mixtures during vermicomposting. The vermicompost obtained showed an increasing trend in heavy metal content in all the reactors, but remained within the range of the allowable content for the vermicompost (*Tables 2* and *3*). Increases in total Kjeldahl nitrogen, total potassium and total phosphorus (TKN, TK and TP) were recorded in EFB as compared with OPT and OPF, and these nutrient contents were comparable to the nutrient content of vermicompost from other lignocellulosic materials. Analysis of the morphological structure of the vermicompost using scanning electron microscopy (SEM) proved that the degradation process occurred in the oil palm fibre.

SMALL-SCALE EXPERIMENT

In a small-scale experiment, vermicomposting was carried out in five 1-m^3 racks of a three-tier wooden vermireactor containing a stable and very active population of the African Nightcrawler earthworm. Each tier of the vermireactor can hold a maximum of 75 kg of feed mixture with 2 kg of the earthworm. The substrates were prepared using EFB amended with animal waste (cow dung) in different ratios, and the same setup without earthworms was also maintained as a control. Composting plus subsequent vermicomposting was carried out by first composting the substrates using selective effective microbes for 20 days to soften and reduce the time required for composting to less than 3 months. Vermicomposting was then carried out in the 1-m^3 vermireactor racks

RESULTS

TABLE 1. CHEMICAL ANALYSES OF VERMICOMPOST SAMPLES

Identity	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Cu (mg kg^{-1})	Zn (mg kg^{-1})	Mn (mg kg^{-1})	Fe (mg kg^{-1})	B (mg kg^{-1})	C/N
Final vermicompost	1.87	0.215	0.76	0.69	0.25	14.3	70.4	221.9	541.0	26.7	18.0
Compost without earthworms	1.31	0.152	0.57	0.59	0.21	13.0	65.7	220.4	569.7	26.5	36.2
Vermicompost in day 2	1.77	0.254	0.33	0.96	0.25	15.7	81.2	380.7	573.4	29.4	21.8

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for 30 days. The moisture content of the feed mixtures was maintained at 75% - 80% by watering twice a week. Samples were collected from the top layer of the vermireactor rack (after 30 days of vermicomposting) once the feed mixture had been processed by the earthworms. *Tables 4* and *5* show the investment in vermicomposting process over one year.

TABLE 2. THE STANDARD RANGE OF NUTRIENTS IN VERMICOMPOST

Nutrient		Range
Organic carbon	(mg kg^{-1})	9.15 - 17.98
Total nitrogen	(mg kg^{-1})	0.50 - 1.50
Available phosphorus	(mg kg^{-1})	0.10 - 0.30
Available potassium	(mg kg^{-1})	0.15 - 0.56
Copper	(mg kg^{-1})	2.00 - 9.50
Iron	(mg kg^{-1})	2.00 - 9.30
Zinc	(mg kg^{-1})	5.70 - 11.50
C/N ratio		<20%

Source: Radha D. Kale (1998).

TABLE 3. ALLOWABLE LIMITS FOR CERTAIN PARAMETERS AS SPECIFIED BY THE MALAYSIAN ORGANIC SCHEME (DEPARTMENT OF AGRICULTURE)

Parameter	Range (mg kg^{-1})
Moisture	<35 % (allowance +10%)
Organic matter	>50% (allowance -10%)
pH	5.5-7.5
C/N ratio	<13% (allowance +20%)
Copper	300
Zinc	1500

INVESTMENT IN VERMICOMPOSTING OVER ONE YEAR

TABLE 4. FIRST CYCLE OF INVESTMENT (DURATION: TWO MONTHS)

Material	Price (RM)	
Worm food supplement	100.00	
African Nightcrawlers (RM 150.00 kg^{-1})	4 500.00	(30 kg)
Composting microbes	200.00	
Fertiliser harvester (140 kg hr^{-1})	3 000.00	
EFB (RM 15.00 t^{-1}), wet	7.80	(500 kg)
Cow dung (RM 3.00/25-kg bag)	60.00	(500 kg)
3-tier racks x 5	500.00	
Miscellaneous equipment	200.00	
Total	**8 567.80**	

Note: * The first cycle will take around two months and yield 700 kg of vermicompost. The sixth cycle production produces 4200 kg of vermicompost annually.

TABLE 5. SIXTH CYCLES IN ONE YEAR

Item	Price (RM)	
Sales of vermicompost fertiliser (@ RM 2.00 kg^{-1})	10 500.00	(for 4200 kg)
Sales of earthworms (@ RM 150.00 kg^{-1})	4 500.00	(for 30 kg)
Vermiwash, 4-litre bottle (@ RM 20.00/4 l)	525.00	(for 105 l)
Total	**15 525.00**	

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