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Research Article

Compost maturity test for Empty fruit bunch of palm oil industry solid waste

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Abstract: A laboratory experiment was carried out to determine the compost maturity of empty fruit bunch of oil palm. The compost sample collected at the end of the 90th day gave good results for the physico-chemical, qualitative and phyto toxicity test for compost maturity. The starch iodine test showed complete decomposition of the polymers. The sulphide test showed the absence of phytotoxic compounds such as H_2S and confirmed the maturity of the compost. The humic acid content at the end of the composting ranged from 10.8 and 14.3 per cent. The highest germination percentage of 81 per cent was observed in radish which indicated that the compost obtained from empty fruit bunch of oil palm fully matured and safely used for agriculture.
Keywords: Oil palm, Empty fruit bunch, compost maturity test, Germination test.

Introduction

Palm oil empty fruit bunch is waste residue generated from palm oil industries. After harvesting fresh fruit bunches from oil palm tree, these bunches are sterilized in a horizontal steam sterilizer to inactivate enzymes present in pericarp and loosen fruits from bunches [1]. The sterilized bunches are fed into a rotary drum thresher in order to remove the sterilized fruit from bunches. These bunches without fruit are called as empty fruit bunch (EFB) which are conveyed to the damping ground, whereas the sterilized fruits are further used as feedstock for palm oil production in palm oil extraction process by means of screw type press. The effluents from screw type press are nuts and fibers which are separated from each other by cyclone. After this separation, nuts are cracked into shells and kernels. The former are solid waste and left unused, the latter are sent to the kernel oil mill [2-3]; It was reported that 20-22 tons of empty fruit bunch, 14 tons oil-rich fiber and 5 tons of shell are generated from 100 ton of fresh fruit bunch [4-5]; This residue may cause environmental pollution problems and spread diseases.

Composting of Empty Fruit Bunch (EFB) and Palm Oil Mill Effluent (POME) is one of the alternative ways to reduce the amount of by product and towards the zero emission programs in palm oil mill industry [6-7]. The composting process typically undergoes a series of temperatures which are rapid increase in temperature, a period of sustained high temperature and followed by the slow cooling of the compost [8]. EFB contain a high proportion of cellulosic matter which is easily decomposed by a combination of physical, chemical and biological processes. The quality of compost mainly depends on the level of organic matter stability [9]. Application of unstabilized organic materials could affect both crops and the environment because of the presence of phytotoxic compounds [10]. The presence of organic acids in the immature compost has also been described as the cause of its phytotoxicity. Hence the present investigation was carried out to determine the maturity of compost obtained from empty fruit bunch.

Materials and Methods

Compost maturity is the stage at which the organic waste becomes the organic manure and can be applied to the crops. In the composting experiment, after 90 days of composting process, samples were drawn and subjected to different compost maturity tests, both qualitative and humification parameters.

(i) Physico- chemical methods

The organic carbon and total nitrogen content of the composted empty fruit bunch was recorded as per the standard method given Walkey and Black [11] and Bremner [12].

(ii) Qualitative tests

a. Starch iodine test

About one gram of finely powdered compost sample was placed in a 100 ml beaker and a few drops of ethanol were added to wet the samples. About 20 ml of perchloric acid was added to the samples, stirred and filtered through a filter paper. A few drops of the filtrate were placed on a white tile and 2 drops of iodine reagent was added to it. Matured compost gives a yellowish colour and very little precipitate; poor or immature compost gives dark colour and heavy precipitation [13].

b. Sulphide test

One gram of finely powdered compost sample was taken in a test tube and inserted with a lead acetate strip into a sample. To this 18 per cent Hydrochloric acid was added to the compost through the wall of the test tube without touching the lead acetate strip. The test tube was

covered with rubber cork and the colour change in the strip was observed.

(iii) Humification parameters

The quantitative test for compost maturity involves the determination of humification parameters. 100 ml of 0.5 N NaOH was added to 10 g of compost in beaker and incubated overnight. The extract was centrifuged at 8000 rpm for 10 min. 10 ml of the supernatant was used for the estimation of organic carbon (C_{ex}) as per the procedure given in Table 3.1. The remaining supernatant was acidified with 2 N Hydrochloric acid and centrifuged at 8000 rpm for 10 min. Again 10 ml of the supernatant from the acidified extract was used for the estimation of organic carbon (C_{fa}) as per the procedure given in Table 3.1. The organic carbon content of the residue (C_{ha}) was also analysed as per the procedure given in Table 3.1. Using these values, the total organic carbon content [14], humification parameters like humic acid per cent, fulvic acid per cent[15] polymerization ratio, degree of humification and humification rate[16] were determined.

Humic acid (per cent) = $(C_{ha}/C_{ex}) \times 100$
Fulvic acid (per cent) = $(C_{fa}/C_{ex}) \times 100$
Degree of humification = $[(C_{ha}+ C_{fa})/C_{ex})] \times 100$
Humification rate = $[(C_{ha}+C_{fa}) /TOC) \times 100$
Polymerization ratio = C_{fa}/C_{ha}

(iv) Phytotoxicity assay

Water extract of the compost was taken under suction and radish seeds were used for this test. The seeds were positioned at equal spacing in petridishes lined with filter paper containing one ml of water extract and were incubated at 27ºC under dark condition. The germination percentage was calculated after 24 h of incubation.

Results and Discussion

C/N Ratio

The compost obtained from empty fruit bunch of oil palm was dark brown colour and damp earthy odour. The C/N ratio of the compost ranged from 16.1 to 25.1. The fully matured compost should have damp earthy odour and dark brown colour [17-18]. The fully matured compost should have the C/N ratio of less than 20, preferably of the order of 15[19]. Proper composting results in conservation of nitrogen and transformation of carbon in the wastes to CO_2 and humic substances. The ideal C/N ratio of mature compost is 10 to 20[20].

Starch iodine and sulphide test

The composted Empty fruit bunch of all the treatments were subjected to starch iodine test on 90th day composting process. Yellow coloured solution without any precipitate was observed in all the treatments, indicating the maturity of the compost. Regarding the sulphide test, absence of black colour was observed in all treatments (Table 1). The starch iodine test showed complete decomposition of the polymers. The sulphide test showed the absence of phytotoxic compounds such as H_2S and confirmed the maturity of the compost. This is in agreement with Bernal *et al.* [21] who reported that phytotoxic substance if any present in wastes or produced during the initial period of composting as intermediate products of metabolism may get degraded producing safe mature compost.

Humification parameters

The quantitative tests for compost maturity involved the estimation of humification parameters on the 90th day sample of the composted Empty fruit bunch. The humic acid content of the composted Empty fruit bunch showed significant difference among the treatments. The humic acid content varied from 10.8 to 14.3 per cent in different treatments (Table 1). The maximum humic acid (14.3 %), fulvic acid (11.4 %), degree of humification (25.8 %), humification ratio (21.6) and Polymerization ratio (0.72) contents were observed in T_6 (EFB + *Streptomyces* sp. + *Bacillus* sp. + *Phanerochate chrysosporium*). Humic substances present in compost are good indicators of compost maturity. The humic acid content at the end of the composting ranged from 10.8 and 14.3 per cent, which indicated high humification and maturity of the compost. This is in conformity with the observations made by Bernal *et al.* [21]. The ratio between carbon content in humic acid and fulvic acid ranged between 0.8 and 1.27, which is considered as the indication of compost maturity according to Jimenex and Garcia[22]. Higher value of humic acid, degree of humification, Cha/Cfa and lower value of fulvic acid and polymerization ratio are indices of compost maturity. This indicates that the compost prepared from palm oil solid wastes (EFB) attained maturity. Similar results of compost maturity indices also reported by Kalaiselvi and Ramasamy[23].

Phytotoxicity assay

Phytotoxicity test for the composted Empty fruit bunch was carried out with radish seed. Among the treatments, T_6 (EFB + *Streptomyces* sp. + *Bacillus* sp. + *Phanerochate chrysosporium*) recorded the highest germination percentage (81 per cent) and the lowest germination per cent was observed in T_1 (EFB + FYM; 61 per cent) (Table 1). This was in accordance with Zucconi *et al.* [24], who indicated that compost showing more than 80 per cent germination is free of phytotoxic compounds. Hampton *et al.* (1998) [25] also reported that germination per cent of more than 60 is a good indication of matured compost. According to the phytotoxicity classification by Woods [26], the Empty fruit bunch compost can be classified under non-inhibitory category (class IV).

Table 1.Compost Maturity Test: Qualitative test, humification parameters and phytotoxicity assay of the composted EFB

Treatments	Qualitative test		Humification parameters						Germination (%)
	Starch iodine test	Sulphide test	Humic acid (%)	Fulvic acid (%)	Degree of Humification (%)	Humification ratio	Polymerization ratio	C/ N ratio	Radish seed germination (%)
T_1	+	-	11.7	9.43	25.1	16.3	0.83	25.1	61
T_2	+	-	11.3	8.34	19.7	20.6	0.73	20.4	72
T_3	+	-	12.3	10.1	22.5	20.5	0.82	18.2	75
T_4	+	-	10.8	8.86	19.7	16.4	0.81	17.5	74
T_5	+	-	12.7	10.4	23.0	17.6	0.75	16.4	78
T_6	+	-	14.3	11.4	25.8	21.6	0.72	16.1	81
T_7	+	-	12.1	10.3	22.4	18.4	0.85	21.3	62
Mean			**12.2**	**9.8**	**22.6**	**18.8**	**0.79**	**19.3**	**72**
SEd			0.406	0.162	0.9321	1.702	0.025	0.47	1.17
CD (0.05)			0.871	0.349	1.200	3.651	0.053	1.01	2.51

Conclusion

As the world palm oil demand is increasing generation of waste is also increasing. If they are discharged untreated, they may cause serious problem and deteriorates the environment in contact. Thus environmental management through waste management should be given main emphasis. There is a need of appropriate waste minimization or recycling technology which should be easy to operate and cost effective. Use of composting technology is also an efficient waste management option. Using compost in agriculture will help in recycling the plant nutrients and help the soil from soil degradation. Application of unstabilized organic materials could affect both crops and the environment because of the presence of phytotoxic compounds. The compost obtained from the empty fruit bunch of oil palm was fully matured and used as a manure for crops.

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