International Journal of Oil Palm, 2 (1): 33 - 35, June 2001

RESEARCH PAPER

Changes in Certain Chemical Parameters During Composting of Oil Palm Wastes

H.L. Swayamprabha, P.Thomas Varghese and S. Sunitha
National Research Centre for Oil Palm, Regional Station, Palode, Pacha-695 562
Thiruvananthapuram District., Kerala, India.

ABSTRACT

Influence of various composting treatments and microbial inoculants on changes in certain chemical parameters governing maturity of oil palm waste compost was studied. The parameters included C/N ratio, primary and secondary nutrients, Cation Exchange Capacity (CEC), Biodegradability Index (BI), Water Soluble Carbohydrate (WSC) and Cellulose degradation percent. Compost attained maturity within 150 days when unchopped Oil Palm waste materials including the highly lignified petiole portions were used. Availability of large quantity of waste materials coupled with the rich nutrient status of the compost prepared makes it a suitable organic manure in oil palm plantations as a substitute for the costly inorganic fertilizers.

Key words: Oil palm waste, composting, C/N ratio, compost maturity, Biodegradability Index.

INTRODUCTION

Substantial quantities of crop residues are produced from oil palm plantations. The byproducts/wastes *viz.*, fronds, empty fruit bunches (EFB), mesocarp waste and shell are available to the tune of about 15 tonnes per ha of a plantation. Varghese (1994) reported the content and removal of nutrients in various palm parts based on a fertilizer experiment in mature oil palm plantation. Of these palm parts, fronds and EFB constituted the major component of waste material in oil palm plantations, which can be composted through different techniques. Direct mulching of these waste materials in the plantation may pose several difficulties depending on location and management like temporary immobilization of nutrients, harbouring rats and snakes, risk of fire and enhancing multiplication of pests. One of the prime requirements in the production of composted manure is to reduce the period of composting and to improve its nutrient status. There are various methods to assess the quality of compost, of which the easiest way is to observe the physical appearance, which alone cannot give a clear picture on the real quality of the manure produced (Talashilkar *et al.*, 1999). Good compost should be dark brownish-black, friable and having earthy odour. The present study was undertaken to monitor the changes in certain chemical parameters governing the process of decomposition at regular intervals so as to reduce the composting period and to enhance the nutrient concentration.

MATERIALS AND METHODS

Oil palm wastes consisting of 350 kg fronds and 150 kg EFB (on fresh weight basis) were composted in pits of size 3 x 1 x 0.5 m during July 2000. Composting was carried out in sheds protected from rain. The bottom and sides of the pit were compacted using earthen slurry. The palm wastes were placed in layers in the compost pits in the following order (i) First layer of 116.5 kg fronds (fresh weight basis), each frond cut into three parts, (ii) Second layer of 10 kg Cowdung slurry and 1 kg urea, (iii) Third layer of 75 kg EFB (unchopped) and (iv) Fourth layer of 10 kg Cowdung slurry and 1 kg urea. The sequence was repeated to place the entire 500 kg of waste inside the pits. In the case of vermi composting, only cow dung was used and urea was not added.

There were six composting treatments with four replications including a control as given in Table 1. For vermi composting treatments, the earthworm species *Eudrillus eugineae* was introduced only after one month of incubation. Two combinations of microbial cultures were also tested. In one treatment, a mixed inoculum comprising *Trichoderma, Fusarium* and *Aspergillus* and in the other a combination of *Pluerotus opuntia* and *Polyporus arcularius* were used. Similar to vermi composting, in microbial treatments, the inoculum was applied after one month of incubation. During the decomposition period of 150 days, water was sprinkled frequently to compensate the loss of moisture. To provide aeration in aerobic treatment weekly turning was carried out and in others turning was done once in 15 days. Compost samples collected from each treatment were dried and analysed for N, P, K, Ca, Mg, CEC. (Jackson, 1962). On completion of composting, yield of compost was determined in each treatment (Verma, *et al.*, 1999).

The Biodegradability Index (BI) was calculated as an index of maturity of compost by determining water soluble carbohydrate (WSC) in relation to total organic carbon (TOC) and the age of compost (in days), using the equation, BI = 3.166 + 0.039 TOC + 0.832 WSC – 0.0110 days (Manna and Ganguly, 1999).

RESULTS AND DISCUSSION

(i) Number of days required for the maturation of compost

The period required for attaining maturity of compost was viewed from colour, texture and structure of oil palm wastes. Since the materials were unchopped, only leaflets got decayed during the first 60 days. After 60 days the petiole and bunch wastes got degraded and became smaller pieces in all treatments. The degradation was fastest in vermi composting followed by microbial treatment and aerobic treatment. The degradation of EFB was faster in the treatment wherein compost was used as starter. In all the treatments maturity was attained between 130 – 140 days whereas a maximum period of 150 days was taken in the control.

(ii) C/N ratio

A gradual reduction in C/N ratio of oil palm wastes was observed with the advancement of composting period. The C/N ratio of the wastes (substrates) prior to composting were 25:1, 90-95:1 and 55-60:1 in the case of leaflets, rachis and petiole and EFB respectively. C/N ratio observed at monthly interval in different treatments is given in Table 1. After 150 days *i.e.,* for the mature compost, the C/N ratio has reached a very favourable value of 9-13: 1 in all the treatments except in control.

(iii) Primary and secondary nutrients

Compost samples collected after 150 days of decomposition were analysed for primary and secondary nutrients (Table 2). The microbial treatment with the mixed cultures of *Pleurotus opuntia* and *Polyporus arcularius* (T_3) and vermi compost (T_5) have recorded the highest value of N, P, K, Ca and Mg. The rich nutrient status of the made compost from oil palm wastes in oil palm plantations indicates the possibility of making large quantities of compost utilizing the bulk wastes available in the plantation.

Table 2: Nutrient levels of mature compost (% dry weight)

Treatments	N	P	K	Ca	Mg
T_1	2.07	0.18	1.22	0.80	0.20
T_2	1.60	0.18	0.98	0.80	0.03
T_3	2.26	0.20	0.68	0.80	0.30
T_4	1.76	0.19	0.68	0.60	0.22
T_5	2.05	0.20	0.98	0.90	0.24
T_6	1.58	0.12	0.68	0.50	0.14

(iv) Biodegradability index (BI)

The total Organic Carbon (TOC), Water Soluble Carbohydrate (WSC) and Biodegradability Index (BI) were lower whereas the CEC and CEC/TOC were higher in the treatments compared to the control. Reduction of BI occurred when the carbonaceous matter decreased and mineral components increased (Table 3).

Table 1: Details of composting treatments and C/N ratio recorded.

	Treatments	Starters used	C/N ratio during the process of composting (days after compost preparation)				
			30	60	90	120	150
T_1	Aerobic	10 percent Cowdung + 1 percent Urea	61	57	44	28	13
T_2	Compost starter	"	63	59	42	25	12
	Microbial treatments						
T_3	(i) *Pluerotus opuntia* & *Polyporus arcularius*	"	65	58	42	24	10
T_4	(ii) *Fusarium, Aspergillus* & *Trichoderma*	"	63	57	43	26	13
T_5	Vermi compost	30 percent Cowdung	60	56	40	21	9
T_6	Control	Nil	65	60	52	35	19

Table 3: TOC, WSC, CEC and BI of mature compost

Treatments	TOC (% dry wt)	WSC (% dry wt)	CEC (meq/100g)	BI	CEC/ TOC
T_1	26.42	0.35	52.95	2.84	2.00
T_2	18.56	0.57	44.30	2.70	2.39
T_3	19.72	0.97	59.30	3.09	3.01
T_4	23.2	0.87	52.90	3.15	2.28
T_5	17.4	1.00	56.00	3.02	3.32
T_6	26.68	3.17	42.00	4.36	1.57

(v) Cellulose content

Cellulose levels were estimated in all oil palm wastes (substrates) prior to composting and in the made compost. All the treatments except control exhibited almost the same quality degradation ability of cellulose. The initial cellulose content of substrates in mg/100g were 92.6, 197 and 365.3 in the case of leaf, petiole and EFB respectively.

The percent reduction of cellulose recorded in the final compost in different treatments were as follows:

T_1 – 78.4, T_2 – 81.3, T_3 –78.3, T_4 –77.9, T_5 –77.9 and T_6 – 63.4.

High level of cellulose degradation (78-80 %) is observed in treatments, which indicates the activity of cellulose degrading organisms. This warrants the isolation of the organisms which have high cellolytic properties and exploit for reduction of the composting period.

(vi) Yield of compost

In all the treatments 70-75 per cent recovery was obtained. In oil palm compost, about 10-13 per cent comprises of petiole, which is the highest lignin containing component of oil palm wastes. It is inferred that the rate of decomposition of oil palm wastes and compost maturity is determined by the chemical parameters such as C/N ratio, CEC, cellulose degradation, BI and WSC. Though compost maturation can be evaluated using these parameters , the quality of compost is mainly determined by its nutrient status.

Economics of production of compost from the wastes available from a hectare of plantation and its nutrient contribution has been reported by Sunitha and Varghese(1999). Nutrients to the extent of 170 kg N, 45 kg P, 135 kg K and 35 kg Mg could be obtained from 10 tonnes of compost expected approximately from a hectare of plantation wastes. Thus, almost the full requirement of nitrogen, 50 per cent requirement of phosphorus and 75 per cent requirement of potassium of palms could be met. Thus in a plantation, if the entire quantity of the waste materials, particularly pruned leaves and EFB could be used for composting, the consequent organic manure produced can substantially substitute the inorganic fertilizer demand of the palms thus making the plantation system economically and ecologically sustainable.

REFERENCES

Jackson, M.L. 1962. *Soil Chemical analysis,* Prentice-Hall, INC, Englewood Cliffs, N.J,p.

Manna, M.C. and Ganguly, T.K. 1999.Composting- an enrichment technology. *Indian Farming,* **49**: 14-16.

Sunitha, S. and Varghese, P.T. 1999. Composting of Oil Palm wastes for efficient recycling of nutrients in palm plantations. *The Planter,* **75**: 677-681.

Talashilkar, S.C., Bhangarath, P.P. and Metha, V.B. 1999. Changes in chemical properties during composting of organic residues as influenced by earthworm activity. *Journal of the Indian Society of Soil Science,* **47**: 50-53.

Varghese, P.T. 1994. Effect of nutrition as influenced by irrigation on growth and yield of Oil Palm (*Elaeis guineensis* Jacq.) *Ph. D. Thesis,* Kerala Agricultural University, Kerala, India,p.319.

Verma, L.N., Rawat, A.K. and Rathore, G.S. 1999. Composting process as influenced by the method of aeration. *Journal of Indian Society of Soil Science,* **47**: 368-371.