

COMPARISON OF TECHNIQUES FOR ORGANIC MANURE PRODUCTION FROM PLANTATION WASTES

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ABSTRACT

The studies on organic manure preparation from plantation wastes viz. coir pith, areca wastes and coffee husk revealed that recovery per cent was highest in case of coffee husk followed by areca waste and coir pith. Highest recovery was recorded using chemical technique followed by anaerobic, aerobic and lastly microbial (*Pleurotus sajor caju*) technique. The C/N ratio was found to be the least in areca waste (7.82) and amongst the methods of composting, it was aerobic method (8.73). The nutritive value (N, P, K, Ca and Mg) of final compost was found to be more than the base material used. The pith - fibre ratio decreased to as low as 3.3 from initial value of 7.3 after composting of coir pith. The microbial load was higher for areca and coffee husk compost over their base materials. The cost of preparation of organic manure was found to be the least in chemical followed by anaerobic technique.

Keywords: Composting, Organic manure, Plantation wastes, Methods of Quality

INTRODUCTION

Human consciousness towards health, hygiene and quality of life has resulted in shift in emphasis from chemical farming to organic farming. Secondly, the availability of fertilizers or their use does not commensurate with the adequate nutrient requirement of the crops. The nutrient requirement for plantation crops is estimated to increase from 420 thousand tonnes at present to 755 thousand tonnes by 2000 AD. However, the supply through fertilizers will meet only 50% of the total nutrient requirement by that time. Therefore, main dependence will be on organic sources which could supply 165 thousand tonnes of the nutrients (Nair *et al.* 1996). Wastes/usufructs, from plantation crops account for more than 30-50% of the produce (Biddappa *et al.* 1996). Though these wastes have been utilized for many purposes earlier, with improvement in standard of living, the wastes utilization has declined. These plantation wastes are generally lignocellulosic in nature with high phenolic content. The wider C:N ratio coupled with low N content, presence

of soluble tannin related phenolic compounds (8-12%) are some of the problems associated with direct application of coir pith to the crops (Fan *et al.* 1982). These wastes/usufructs can be recycled back to soil, thereby, augmenting the chemical nutrient supply apart from other pronounced soil fertility improvements. Work carried out at CPCRI Research Centre at Palode on oilpalm wastes revealed the importance of composting for waste management (Anon. 1996). Compositing is one of the most important methods for recycling plantation wastes. It reduces the C:N ratio and bulkiness of compost, thereby improving the quality of compost. The present investigation aims at studying the effect of various techniques on the organic manure preparation from plantation wastes viz. coir pith, areca wastes and coffee husk.

MATERIALS AND METHODS

The experiment to study the effect of various composting techniques viz. anaerobic, aerobic, microbial (*Pleurotus sajor caju* addition) and chemical on the

recovery and nutritive quality of three different plantation wastes viz. coir pith, areca wastes and coffee husk was initiated in August, 1995. The maximum temperature during this period ranged from 28.9 to 31.1°C and minimum temperature from 21.3 to 21.8°C. The experiment was based on completely randomised factorial design with two replications. Areca wastes excluding areca husk viz. bunch waste, dry fronds and rachis were collected and chopped. Coffee husk and chopped areca wastes were left for 20 days for precuring with water to soften it.

Coffee husk, coir pith and areca wastes, 30 kg each were then stacked for composting studies using different composting techniques as given in Table 1. The composting was done for 2 months. Pith-fibre ratio was also studied in raw and composted coirpith.

The nutrient content of base and composted materials were determined following procedure adopted by Jackson (1967). The nutrient content of base

material is shown in Table 2. Microbial load in base and composted materials were estimated by serial dilution technique. The recovery percentage was worked out on dry matter basis by using oven dry technique.

RESULTS AND DISCUSSION

The present investigation revealed that after two months of composting, on dry weight basis, the recovery percentage varied from as high as 83.95% for areca wastes composted using chemical technique to 61.7% for areca wastes compost using microbial technique (Table 3). Table 3, also shows significant difference between different base materials used as well as the methods of composting. The mean values of different techniques indicated highest recovery of 82.31% for chemical technique followed by anaerobic, aerobic and lastly microbial. In anaerobic technique the recovery is more because, wastes were composted under anaerobic condition wherein the loss due to decomposition in

Table 1: Methods of composting

Methods	Procedure followed
1. Anaerobic	10 kg base material + urea + 10 kg base material + urea + 10 kg base material + urea + 10 kg base material + urea + 10 kg base material covered with soil at the top.
2. Aerobic	10 kg base material + urea + 10 kg base material + urea + 10 kg base material + urea + 10 kg base material + urea + 10 kg base material. Every four days thorough mixing was done.
3. Microbial (addition of <i>Pleurotus sajor caju</i>)	10 kg base material + urea + 10 kg base material + <i>Pleurotus sajor caju</i> + 10 kg base material + urea + 10 kg base material + <i>Pleurotus sajor caju</i> + 10 kg base material
4. Chemical	10 kg base material + urea mixed with rock phosphate + 10 kg base material + urea mixed with rock phosphate + 10 kg base material + urea mixed with rock phosphate + 10 kg base material + urea mixed with rock phosphate + 10 kg base material covered with soil at the top.

Urea was applied @ 10kg/tonne of base material

Rock phosphate was applied @ 10kg/tonne of base material

Pleurotus sajor caju was applied @ 5 kg/tonne of base material

that the C:N ratio is least in aerobic and microbial treatment compared to anaerobic and chemical treatment. However, in all the cases the C:N ratio is less than 20, which is desirable and serves as an indicator of the maturity and the stability of the organic substrate (Alexander, 1977; Golueke, 1977; Stevenson, 1982).

Among the base materials, the recovery percentage was found to be highest in case of coffee husk, followed by areca waste and coirpith. This can be corroborated based on initial C:N ratio. A perusal of Table 2 reveals that C:N ratio for coir pith is 103.14 followed by 22.2 for areca wastes and 21.38 for coffee husk. More the carbonaceous material and less the N content of the base material, less is the recovery as there is higher release of

carbon dioxide. The mean organic carbon content (%) of the base materials decreased from initial values of 29.882 to 25.82 for coir pith, 29.072 to 23.58 for areca wastes and 37.2 to 30.04 for coffee husk. Reduction in org. C content of coirpith has also been reported by Nagarajan *et al.* (1985). Amongst the methods of composting, the mean O.C. (%) was least in aerobic (25.22) and microbial (25.24), which was significantly different from chemical (28.12) and anaerobic technique (27.74).

Significant differences between the nitrogen content of the composted materials were found (Table 5). The N content of the final compost was higher than the initial N content of base materials used. Highest N content was recorded in areca waste compost

Table 5. Nitrogen content (%) of composted materials.

Source of base materials	Methods of composting				
	Anaerobic	Aerobic	Microbial	Chemical	Mean
Coir Pith	2.220	2.595	1.915	2.140	2.217
Areca wastes	2.030	3.535	3.980	3.480	2.256
Coffee husk	3.065	2.760	2.830	3.040	2.924
Mean	2.438	2.963	2.908	2.887	
CD (p=0.05)	Base materials	0.039			
	Methods of composting	0.045			
	Interaction	0.079			

Table 6. Phosphorus content (ppm) of composted materials.

Source of base materials	Methods of composting				
	Anaerobic	Aerobic	Microbial	Chemical	Mean
Coir Pith	231.300	272.400	274.800	13006.000	3446.125
Areca wastes	236.000	415.500	434.000	15350.000	4108.875
Coffee husk	816.050	1075.800	764.250	5372.000	2007.025
Mean	427.783	587.900	491.017	11242.667	
CD (p=0.05)	Base materials	68.00			
	Methods of composting	78.50			
	Interaction	136.00			

using microbial technique. Mean values indicated highest N content in aerobic treatment (2.963%) and areca waste compost (3.256%). The lower values in anaerobic and chemical treatment could be due to dilution effect on account of higher recovery.

In general, it has been found from analysis of composted materials, the nutrient content of the final compost was always higher than the base material used with reference to phosphorous (P_2O_5), potassium (K_2O), calcium and magnesium. Perusal of Table 6 revealed higher P_2O_5 content in case of chemical treatment. This is because rockphosphate was added. The higher values obtained in case of coir pith compost and areca waste compost using chemical technique may be due to the reason that rock phosphate granule might not have been

chemically broken and have come into sample. Amongst the base materials composted, values have been recorded higher in case of areca and coirpith compost.

Significant differences between the potassium content of the composted materials and the techniques used were found (Table 7). Amongst the base materials used, the mean K_2O content was highest in case of areca wastes compost followed by coffee husk and then, coirpith. Among the techniques used, aerobic treatment gave the highest value of 0.602% K_2O and least value of 0.534% were obtained in case of anaerobic technique. This is quite understandable in view of the dilution effect due to higher recovery per cent in anaerobic and chemical technique.

Regarding calcium content, it was found that mean values of chemically treated

Table 7. Potassium content (%) of composted materials.

Source of base materials	Methods of composting				
	Anaerobic	Aerobic	Microbial	Chemical	Mean
Coir Pith	0.215	0.307	0.387	0.383	0.323
Areca wastes	0.747	0.762	0.705	0.748	0.740
Coffee husk	0.641	0.735	0.605	0.565	0.637
Mean	0.534	0.602	0.566	0.565	
CD (p=0.05)	Base materials	0.006			
	Methods of composting		0.007		
	Interaction		0.013		

Table 8. Calcium content (ppm) of composted materials.

Source of base materials	Methods of composting				
	Anaerobic	Aerobic	Microbial	Chemical	Mean
Coir Pith	4466.00	3109.00	3367.50	4555.00	3874.38
Areca wastes	4446.50	5078.00	4779.00	9730.50	6008.50
Coffee husk	3936.00	4088.50	3888.50	7908.00	4955.25
Mean	4282.83	4091.82	4011.67	7397.83	
CD (p=0.05)	Base materials	3.565			
	Methods of composting		4.117		
	Interaction		7.130		

Table 9. Magnesium content (ppm) of composted materials.

Source of base materials	Methods of composting				Mean
	Anaerobic	Aerobic	Microbial	Chemical	
Coir Pith	1639.00	2603.50	3277.00	1767.50	2321.75
Areca wastes	1103.00	1213.50	1098.50	1669.00	1271.00
Coffee husk	533.00	708.50	580.50	1115.50	734.38
Mean	1091.67	1508.50	1652.00	1517.33	
CD(p=0.05)	Base materials	4.806			
	Methods of composting	5.549			
	Interaction	9.912			

compost were higher than other treatments (Table 8). This higher increase in chemically treated compost may be due to inadvertent addition of calcium through rock phosphate. Amongst the base materials composted, mean calcium content was found to be higher in case of areca wastes followed by coffee husk and coirpith.

Magnesium content of base materials composted using different techniques differed significantly amongst themselves (Table 9). Highest Mg content was obtained with coirpith compost and least with coffee husk compost. Highest Mg content in coirpith compost may be due to higher initial Mg content in the base material used as well as lower recovery. Amongst the techniques used, highest Mg content was obtained in microbial technique and least in anaerobic technique. This is quite understandable in respect of recovery percentage.

The pith-fibre ratio on composting of coirpith was reduced compared to raw material (7.33). Lowest pith-fibre ratio amongst composting techniques used was

obtained in anaerobic technique (3.30), followed by aerobic (3.34), then, microbial (3.81) and chemical (4.25) technique.

The population of bacteria, actinomycetes and fungi in the raw materials viz. areca leaf and coffee husk and in their composts was estimated, using serial dilution technique (Table 10). Significant differences in bacterial and actinomycetes count were observed between areca waste and areca compost. However, there was no significant difference between coffee husk and coffee husk compost. This may be due to higher bacterial and actinomycetes count in coffee husk base material itself. Similarly, no significant differences were observed in the fungal population between coffee husk and coffee husk compost and areca waste and areca compost. This may also be due to higher fungal load in the base material itself. Areca waste is mainly lignocellulosic and has low C:N ratio. Moreover, it contains more polyphenols and less moisture. All of these factors result in poor microbial colonization. That is why the initial microbial

Table 10. Microbial load in base materials and their composts.

Sl.No.	Substrate	Bacteria (10^5)	Actinomycetes (10^5)	Fungi (10^3)
1	Areca waste	29.33	76.00	186.67
2	Coffee husk	86.00	71.67	383.33
3	Areca compost	53.67	90.67	210.00
4	Coffee husk compost	93.00	74.00	423.22
	CD(p=0.05)	10.58	8.25	43.32

load in areca waste is low. During composting with the addition of urea and improving moisture status, the C:N ratio gets altered and favours microbial colonization. On the other hand, the coffee husk base material being rich in mucilage and nutrients favours more microbial colonization leading to high level of microbial population in the initial raw material itself.

On working out the economics of compost preparation, it was found that chemical and anaerobic techniques are the cheapest techniques (Table 11). This can be further corroborated by their high recovery percentage. Chemical technique apart from an efficient method of organic manure preparation, supplies substantial quantity of phosphorus, calcium, magnesium, sulphur and micronutrients like iron and manganese through the addition of rock phosphate. The

Table 11. Economics of organic manure preparation by various techniques

Source of base materials	Methods of composting (Rs/kg)			
	Anaerobic	Aerobic	Microbial	Chemical
Coir pith	0.53	0.84	0.93	0.50
Areca wastes	0.36	0.58	0.79	0.35
Coffee husk	0.54	0.71	0.85	0.52

microbial technique was found to be the costliest of all the techniques (Anon. 1996).

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REFERENCES

- ALEXANDER, M. 1977. Introduction to Soil Microbiology. John Wiley & Sons Inc. (2nd Ed.).
- ANONYMOUS. 1996. Annual report for 1995-96, Central Plantation Crops Research Institute, Kasaragod, Kerala. 74p.
- BIDDAPPA, C.C., UPADHYAY, A.K., HEGDE, M.R. and PALANISWAMI, C. 1996. *J. Plantn. Crops* **24(2)**: 71-85.
- FAN, L.J., YOUNG-HYUN LEL and GHARNAY, M.M. 1982. *Adv. Biochem. Engg.* **23**: 157-187.
- GOLUEKE, G.C. 1977. Biological reclamation of solid wastes. Rodale Press, Emmaus.
- JACKSON, M.L. 1967. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi 498p.
- NAGARAJAN, R., MANICKAM, T.S., KOTHANDARAMAN, G.V., RAMASWAMY, K., and PALANISWAMY, G.V. 1985. *Madras Agric. J.* **72**: 533-535.
- NAIR, M.K., BIDDAPPA, C.C., PALANISWAMI, C. and UPADHYAY, A.K. 1996. In: Proceedings of Symposium on plant nutrient supply needs, efficiency and policy issues for the years 2000-2025 AD. Kanwar, JS and Katyal, JC (Eds.). National Academy of Agricultural Sciences, New Delhi, India. pp 329.
- STEVENSON, F.J. 1982. Humus Chemistry. John Wiley & Sons Inc.