RESEARCH PAPER:

Ex situ bioconversion of coir waste (*Cocos nucifera*) predigested with *Pleurotus* sp. by using an epigeic earthworm, (*Eudrilus eugeniae*)

M. MURALI AND P. NEELANARAYANAN

Asian Journal of Environmental Science, (June, 2011) Vol. 6 No. 1 : 12-16

See end of the article for authors' affiliations

Correspondence to :
P. NEELANARAYANAN
Centre for Vermibiotechnology, Nehru Memorial College (Autonomus), Puthanampatti, TIRUCHIRAPPALLI (T.N.) INDIA
srialyyam@rocketmail.com

SUMMARY

The processed coir waste *i.e.,* predigested with *Pleurotus* sp. were mixed with cured cow dung in different proportions *viz.*, 50:50, 60:40, 70:30, 80:20, and 90:10 (each concentration in triplicates) and they were filled in plastic trays, individually. Simultaneously, a control was prepared with 50:50 concentration and maintained. Hundred healthy *Eudrilus eugeniae* adult worms were introduced into each of these trays excepting the control. The conversion ratio of waste in to vermicompost was found to be high in 50:50 proportion (61%). The cocoons and young ones production was found to be higher in 50:50 proportion than the other four proportions. Further, vermicompost obtained from 50:50 concentration was found to have desirable level of nutrient composition when compared to the other four concentrations. The results of the present study obviously suggest that the coir waste with cow dung at 50:50 proportions can very well be used for converting into value added vermicompost by utilizing *E. eugeniae*.

Murali, M. and Neelanarayana, P. (2011). *Ex situ* bioconversion of coir waste (*Cocos nucifera*) predigested with *Pleurotus* sp. by using an epigeic earthworm, (*Eudrilus eugeniae*). *Asian J. Environ. Sci.*, **6**(1): 12-16.

Key words : Coir waste (*Cocos nucifera)*, *Eudrilus eugeniae*, Macro and Micronutrients, *Pleurotus* sp., Vermicompost.

Received: *December, 2010*
Accepted : *January, 2011*

Coconut palm (*Cocos nucifera*) is mainly cultivated for nuts. Two important commercial products *viz.,* copra and fibre are obtained from this crop. *C. nucifera* is cultivated in 93 countries across the world and the total area under *C. nucifera* cultivation is 12.05 million hectares. India occupies third place in terms of area under cultivation and production *i.e.,* 1.89 million hectares and 12.821 million nuts/annum, respectively. In India it is primarily a small land holders crop and around 5 million holdings are distributed in 18 states and three union territories (Rathinam, 2005). Coir waste have more moisture retention property (500-600%) and K content, thus they could be exploited for agricultural use. Annual production of coir dust is about 1.39 million tonnes in India and Karnataka alone produces about 140-150 thousand tonnes (Kadalli *et al*., 2000).

The biological degradation and stabilization of organic wastes by earthworms and microorganisms is termed as vermicompostiong. Vermicompost is an excellent plant growth media or soil amendments (Edwards, 1988). Various authors (Bhawalker, 1994; Buchanan *et al.,*1988; Edwards and Burrows, 1988; Tomati *et al.,* 1987), have identified vermitechnology as one of the major techniques in which earthworms do the job of composting *i.e*., to convert waste in to rich humus. *Pleurotus sajor-caju* showed good potentials for degrading the coir waste (Bisaria *et al*,.1987; Ragunathan and Swaminathan, 2003).

Application of vermicompost to crop fields can improve the physico-chemical and biological properties of the soil (Kale, 2006). In the present study, an attempt has been made to convert *C. nucifera* (coir waste) in to vermicompost with the following objectives: to compute the magnitude of conversion of coir waste (*C. nucifera)* into vermicompost using an epigeic earthworm, *E. eugeniae.,* to enumerate the number of cocoons and young ones present in various proportions (of coir waste and cow dung) and to analyse and compare the nutrients' composition of raw coir waste, control and vermicompost.

MATERIALS AND METHODS

The present study was carried out

between March 2008 and May 2008 in Vermiculture unit of Nehru Memorial College (Autonomous), Puthanampatti, Tiruchirappalli district, Tamil Nadu, India. *E. eugeniae* was selected for the present study because of its surface feeding behaviour. The selected coir waste were collected from the Vengangudi and Samayapuram villages near Tiruchirappalli and brought to our college vermished. Then the coir waste were sieved for obtaining a homogenous waste. The predigested food prepared from homogenous waste was found to be favourable for raising *E. eugeniae* (Viljoen and Rekinecke, 1989).

The coir waste were spread on a floor, which was open to sunlight for five days. Watering was done regularly twice in a day on the coir waste. Similar method was adopted for curing cow dung. The sun dried coir waste and cow dung were transferred to a shady place where it was cured for 15 days. Later, 1kg of coir dust was spread on a clean floor. To this 20g of *Pleurotus* sp. spawn culture was broadcasted. Above to this layer 1kg of coir waste was spread. A semisolid slurry mixture was prepared with equal quantity of jaggary (40g) and cow dung (40g) in one litre of water. This semisolid mixture was sprinkled over this layer. A combination of these layers were laid ten times one layer over the other. All these layers were covered by wet pieces of jute bags in order to maintain the moisture content. This set up was maintained for 25 days.

Plastic trays of 45x15x30cm size were bought and used in the present study. At the bottom of the each tray, a hole was made to drain the excess water in the experimental medium. The vermibeds were prepared by mixing the predigested coir waste with *Pleurotus* sp. and cured cow dung in different proportions *viz.*, 50:50, 60:40, 70:30, 80:20 and 90:10 and they were filled in the trays, individually. A control experimental medium was also prepared with 50:50 concentration and filled in the tray, individually. All the above experiments were repeated for three times. After 10 days of the preparation of the experimental media, in each tray, 5 clitellate *E. eugeniae* worms were introduced. The worms entered in to the media immediately after the inoculation. On the subsequent day 95 worms were additionally introduced into each tray, excepting the control ones. These trays were kept undisturbed in a shady place. Watering was done regularly twice in a day in order maintain the temperature and moisture content of the medium during the entire composting period.

After 20 days the vermicompost was collected sieved, air-dried and weighed separately from each tray. The vermicompost was then analyzed to quantify its chemical nutrients' composition. Further, after the harvest in each tray the number of cocoons and young ones were counted and recorded. Various chemical parameters such as pH, Electrical Conductivity (EC) and macro and micronutrients such as total Nitrogen (N), total Phosphorous (P), total Potassium (K), Organic Carbon (OC), total Calcium(Ca), total Magnesium (Mg), total Sodium (Na), total sulphur (S) and Carbon : Nitrogen ratio (C:N) were estimated by following the methods suggested by Tandon (2003). Appropriate statistical tools were used to analyse the data obtained.

RESULTS AND DISCUSSION

Mean number of days required for bioconversion of the selected waste in to vermicompost was 21 days for all the concentrations under study. The mean total weight of the vermicompost obtained after vermicomposting of coir waste were 1223g (50:50), 1120g (60:40), 920g (70:30), 850g (80:20), and 810 g (90:10).The percentage conversion of vermicompost was 61% (50:50), 56% (60:40), 46% (70:30), 42% (80:20) and 40% (90:10) (Table 1).

The mean number of cocoons and young ones produced by *E. eugeniae* was found to be 83 and 22 (50:50); 37 and 15 (60:40); 34 and 14 (70:30); 29 and 18 (80:20); and 22 and 13 (90:10), respectively during the composting period. The cocoons and young ones were found to be higher in the 50:50 proportion than the other four proportions (Table 1).

The chemical analysis of raw coir waste, control and worm converted waste (vermicompost) showed changes in the parameters analyzed (Tables 2 and 3).

Raw coir waste vs. control:

An increase in the values was observed in the parameters viz., pH, EC, total nitrogen, total phosphorus, total sodium, total calcium, and total sulphur. On the other hand, a decreasing trend in the values was observed in moisture, OC, total potassium, total magnesium and C:N ratio (Table 2).

Raw coir waste vs. vermicompost (in all the five concentrations):

An increase in the values was observed in the parameters *viz.,* pH, EC, total nitrogen (except 70:30 and 90:10), total phosphorus, total sodium, total calcium (except 70:30 concentration) and total sulphur. In contrast, decreased values of the following parameters *viz.,* moisture, OC, total potassium, total magnesium and C:N ratio were observed (Tables 2 and 3).

Control vs. vermicompost (in 50:50 concentration):

A marginal increase in the values was observed in

Table 1: Magnitude of composition of predigested food and its bioconversion into Vermicompost by *E. eugeniae*

Particulars	Concentrations				
	50:50	60:40	70:30	80:20	90:10
Weight of coir waste in each tray (g)	1000	1200	1400	1600	1800
Weight of cow dung in each tray (g)	1000	800	600	400	200
Total weight of predigested mixture in each tray (g)	2000	2000	2000	2000	2000
Number of adult earthworms introduced in each tray	100	100	100	100	100
Mean weight vermicompost obtained (g)	1223	1120	920	850	810
Percentage of bio-conversion of vermicompost in each tray	61	56	46	42	40
Mean total number of cocoons observed in each tray	83	37	34	29	22
Mean total number of young ones observed in each tray	22	15	14	18	13

Experiments were conducted in triplicates in each concentration

Table 2: Extent of chemical constituents of raw coir waste, control and vermicompost produced by *E. eugeniae* in 50:50 concentration

Parameters	Raw coir waste	Control (50:50)	Vermicompost (50:50)
pH	6.84	7.24	7.28
EC (dsm^{-1})	0.27	1.28	0.74
Moisture (%)	70	56	60
Organic carbon (%)	33.25	28.91	27.41
Total nitrogen (mg/l)	1.5	2.0	2.0
Total phosphorus (%)	0.21	0.23	0.27
Total potassium (%)	2.62	1.92	2.32
Total sodium (%)	0.85	1.70	1.85
Total calcium (%)	0.07	0.25	0.09
Total magnesium (%)	0.34	0.06	0.08
Total sulphur (%)	0.07	0.96	0.61
C:N ratio (%)	22:16	14:45	13:70

the following parameters such as pH, moisture, total phosphorus, total potassium, total sodium and total magnesium. Contrary to this, a marginal decrease in the values was observed in EC, OC, total calcium, total sulphur and C:N ratio (Table 2).

The nutrients' status of vermicompost depends on the type of waste materials processed by the earthworms (Umamaheswari and Vijayalakshmi, 2004). Earthworm casts usually more neutral pH than the soil. Earthworms also contribute to several kinds of nutrients in the

Table 3: Quantity of chemical constituents of raw coir waste and vermicompost produced by *E. eugeniae* in various concentrations

Parameters	Raw coir waste	Concentrations			
		60:40	70:30	80:20	90:10
pH	6.84	7.28	7.41	7.36	7.23
EC(dsm^{-1})	0.27	0.74	0.46	0.50	0.45
Moisture (%)	70	60.92	67.92	61.72	59.34
Organic carbon (%)	33.25	27.41	23.85	22.41	20.96
Total nitrogen (mg/l)	1.5	2.0	1.5	2.0	1.5
Total phosphorus (%)	0.21	0.27	0.29	0.32	0.26
Total potassium (%)	2.62	2.32	2.29	2.44	1.81
Total sodium (%)	0.85	1.85	1.80	1.27	0.88
Total calcium (%)	0.07	0.09	0.06	0.14	0.08
Total magnesium (%)	0.34	0.08	0.09	0.08	0.07
Total sulphur (%)	0.07	0.61	0.60	0.50	0.51
C: N ratio (%)	22:16	13:70	15:90	11:20	13:97

nitrogenous wastes. High solubility of nutrients in the earthworm casts increases the pH of the cast (Barley, 1961).

An increase in the electrical conductivity values in vermicompost may be due to the presence of exchangeable calcium, magnesium and potassium (Bhatnagar and Palta, 1996). Bouche *et al.* (1977 a and b); Balamurugan *et al.* (1996); Curry *et al.* (1995); Dash and Patra, (1997) and Ramaligam (1997) reported that an increasing trend in nitrogen content could be seen in the vermicompost. Phosphorus is essential for growth, cell division, growth and lengthening of roots and fruit development and early ripening (Tandon, 2003). Calcium combines with pectin in the plant to from calcium pectate which is an essential constituent of the cell wall. It also promotes the activity of soil bacteria concerned with the fixation of free nitrogen (Edwards and Lofty, 1975). The increased content of calcium in vermicompost obtained from the concentration might be due to increased release of calcium humate from earthworm intestine and calcium excreted by calciferous glands (Batt, 1992). An increase in sulphur content in the vermicompost when compared to control and raw coir waste in all the five concentrations might be due to increased level of release of soluble sulphur by microbes (Bhanurekha and Mahavishnan, 2007).

The results of present study obviously suggest that the coir waste predigested with *Pleurotus* sp. at all the concentrations (50:50, 60:40,70:30, 80:20, and 90:10) can be used for converting them in to nutrients rich vermicomposting by utilizing epigeic earthworms, *E. eugeniae*. However, 50:50, and 60:40 concentrations were found to be comparatively better than the other three concentrations for the following reasons:

- Higher rate of bioconversion,
- Number of cocoons produced was high
- Number of young ones produced was high
- Less number of days required for the bioconversion.

In the present study, the time taken for the bioconversion of coir waste into vermicompost was 80 days. Research work is required in order to find out a method in which the bioconversion of these waste will be completed in about 25-30 days or even a lesser than this time limit.

Acknowledgement:

We thank the Management, Principal of Nehru Memorial College, Puthanampatti for their encouragement and help in various ways. We are thankful to Ministry of Environment Forests, New Delhi for extending financial assistance to do this work.

Authors' affiliations:

M. MURALI, Centre for Vermibiotechnology, Nehru Memorial College (Autonomus), Puthanampatti, TIRUCHIRAPPALLI (T.N.) INDIA

Email: pnn31@hotmail.com, pnn31@yahoo.com

REFERENCES

Balamurugan, V., Gobi, M. and Vijayalakshmi, G.S. (1999). Comparative studies on degradation of press mud using cellulolytic fungi and exotic species of earthworms with a note on as gut micro flora. *Asian J. Microbiol. Biotech. Env. Sci.,* **1** (3): 131-134.

Barly, K.P. (1961). The abundance of earthworms in agricultural land and their possible significance in agriculture. *Adv.Agron.* **13**: 249-268.

Batt, V.S. (1992). *Hand book of agriculture*. Indian Council of Agricultural Research, Pusa, New Delhi. 503 p.

Bhanurekha, K. and Mahavishnan, K. (2007). Sulphur for balanced fertilization in crops. *Agrobios Newsletter*, **6** (1): 6.
Bhatnagar, R.K. and Palta, R.K. (1996). *Earthworm: Vermiculture and vermicompostiong*. Kalyani Publishers, New Delhi.

Bhawalker, U.S. (1994). Converting wastes in to resources. *ILEIA Newsletter*, **10** (3): 20-21.

Bisaria, R., Madhan, M. and Bisaria, V.S. (1987). Biological efficiency and nutritive value of *Pleurotus sajor-caju* cultivated on different agro-wastes'. *Biological Wastes,* **19**:239-245.

Bouche, M., A1-Addan, F., Cortez, J., Hammed, R., Heidet, J.C., Femere, G., Mazend, D. and Samin, M. (1977a). Role of earthworms in the nitrogen cycle: *A falsifiable assessment. SPB*, **29**(314): 375- 380.

Bouche, M., Al-Addan, F., Cortez, J., Hammed, R. and Headed, J.C. (1977). *Budget of a tropical earthworm population from observations of their habits*. Murray, London. 320 pp.

Buchanan, M .A., Russel, G. and Block, S.D. (1988). Chemical characterization and nitrogen mineralization potentials of vermicompost derived from different organic wastes. In: *Earthworms in wastes and environmental management* (Edwards, C.A., and Neuhauser, E.F. (Eds.)), SPB Academic Publishing, The Hague. pp. 231-239.

Curry, J.P., Byme, D. and Boyk, K.E. (1995). The earthworm population of a winter cereal field and its effects of soil and nitrogen turnover. *Bio. Fertil. Soils.*, **19**: 166-172.

Dash, M. C. and Patra, U.C. (1997). Density, biomass and energy budget of a tropical earthworm population from a grassland sity on Orissa. *Rev. Ecol. Biol. Soil.*, **16**: 79-83.

Edwards, C.A. (1988). Breakdown of animal, vegetable and industrial organic wastes by earthworms. *Agric. Ecosyst. Environ.,* **24**: 21-31.

Edwards, C.A. and Burrows, I. (1988). The potential of earthworm compost as plant growth media In: *Earthworms in waste and environmental management* (Edwards, C. A. and Neuhauser, E.F. (Eds.)). SPB Academic Publishing. The Hague, Netherland. pp: 211-220.

Edwards, C.A. and Lofty, J.R. (1975). The influence of cultivations on soil animal populations. In: *Progress in soil Zoology* (ed.) (Vanek.J.). Academia, Prague, pp. 399-407.

Kadalli, G. G., Suseeladevi, R., Siddaramappa, R. and Patil, C.R. (2000). Quality and efficiency of valued added coir dust based compost. *J. Indian Soc. Soil Sci.,* **48**(4):141-144.

Kale, R.D. (2006). *Vermicompost : Crown jewel of organic farming*. Jayanthi printery Bangalore, India, 247 pp.

Ragunathan, R. and Swaminathan, K. (2003). Nutritional status of *Pleurotus sp.* Grown on Various agro-wastes. *Food chemistry,* **80**(3): 371-375.

Ramalingam, A. Gangatharan, M. and Kasturibai, R. (2004). Solid state bio-treatment of coir pith and paddy straw. *Asian J. Microbiol., Biotechnol. & Environ. Sci.,* **6**:141-142.

Ramalingam, R. (1997). Studies on the life cycle, growth and population dynamics of *Lampito mauritii* (Kinberg) and *Eudrilus eugeniae* (Kinberg) cultured in different organic wastes and analysis of nutrients and microbes of vermicompost. Ph.D. Thesis, Annamalai University, Annamalai, T.N. (India).

Rathinam, P. (2005). Steps for yield increase survey of Indian agriculture eco-friendly waste management, Kongunadu Arts & Science College, Coimbatore. pp. 7-10.

Tandon, H. (2003). *Fertilizer guide*. Fertilizer development and consultation organization 204-204A, Bhanot Corner, Pamposh Enclave, New Delhi (India).

Tomati, U., Grappelli, A. and Galli, E. (1987). The presence of growth regulators in earthworm-worked wastes. In: Bonvicini Paglioi, A. M., Omodeo, P. (Eds.), *On earthworms*. Modena, Italy, pp. 423 -436.

Umamaheswari, S. and Vijayalakshmi, G.S. (2004). Nutrient status of different vermicomposts. *J. Ecobiol.*,**16**(3): 237-239.

Viljoen, S. A. and Rekinecke, A.J. (1989). Life cycle of the African night crawler, *Eudrilus euguniae* (Oligochaeta). *S. Afr. J. Zool.,* **24**(4): 27-34.