



Utilization of poultry droppings amended with different organic waste in vermicomposition using local earthworms *Perionyx ceylanensis*

M Muruganandham, S Angelina Glorita Parimala

Department of Zoology, ADM College for Women, Nagapattinam, Tamil Nadu, India

Abstract

Vermicomposting application also helps in cost effective and efficient recycling of animal wastes, agricultural residues and industrial wastes into valuable nutrient rich product, namely vermicompost. The aim of this study was poultry droppings (PD) was mixed with rice husk (RH) and sugarcane press mud (SPM) at various proportions and kept for natural stabilization for 15 days and subsequently vermicomposted using native species *Perionyx ceylanensis* for a period of 75 days under laboratory conditions. *P. ceylanensis* was inoculated at the rate of 20g kg⁻¹ of above waste combination. The data revealed *P. ceylanensis* have good biomass increase and cocoon and hatchlings production in all vermicomposting treatments except the treatment with PD alone. Among the different treatments VCPT2, VCPT3, VCPT6 and VCPT7 treatments were better than other studied treatment combinations. The earthworm mortality was higher in treatments those contained more PD proportions. Hence, it can be concluded that among the treatments, equal proportions (1:1:1) of PD, SPM and RH and/or equal proportion of PD and PM is best substrate medium for growth and reproduction of *P. ceylanensis* and also large scale vermicompost production.

Keywords: press mud, poultry dropping, rice husk, vermicomposting, *P. ceylanensis*

Introduction

Rice husk (RH) as by-product of the rice milling, is extensively available in rice producing countries like China and India which contributes 33% and 22% of global rice production respectively. RH content ranges from 16-25% of paddy (Soltani *et al.*, 2015) [1]. Approximately 500 million tons paddy produced by world every year and 120 million tonnes of paddy produced by India, it gives around 24 million tonnes of RH per year (Shwetha *et al.*, 2014) [2]. Further, India is one of the leading growers of sugarcane with an estimated production of approximately 300 million tons in the marketing per year. Enormous amount of solid waste streams generated during sugar manufacturing process including sugarcane trash, bagasse, press mud and bagasse. Mainly sugarcane industry generates huge quantity of residue after the sugarcane juice has been clarified commonly known as press mud. For about 134 million tons of sugarcane crushed, 4.0 million tons of filter mud are generated (Manivannan *et al.*, 2004) [3]. There is a major disposal problem for the filter mud although it is fairly rich in organic nutrients; it finds little use as agricultural fertilizer (Sen and Chandra, 2006) [4].

Similarly, the poultry and livestock industries are growing rapidly along with the human population and production of animal waste are potential sources of many major environmental problems. India is one of the largest producers of poultry in the world and the poultry manure availability is estimated to be 12.1 million tons (The week end leader, 2014) [5]. In the poultry farm large amount of droppings that accumulated in the litter turns it into importance sources of contamination i.e. odorous gases including amines, amides, mercaptans, sulphides and disulphides. These noxious gases can cause respiratory disease in animals and humans

(Schiffamn and Williams, 2005) [6]. However, poultry droppings (PD) along with litter has useful nutrients, and is therefore used as organic fertilizer but uncontrolled decomposition and excess applications to soil can cause environmental problems due to their extremely high levels of nitrogen as ammonia, low pH, and heat generation (Moore *et al.*, 1995) [7]. Due to low density and less commercial interest of these wastes, handling as well as transportation it is problematic, which creates disposal and serious environmental problems.

Therefore, there is an urgent need to recycle the RH, PD and SPM without environmental impact. Numerous technologies are harnessed to deal with the organics that have the feasible to pollute the environment. Existing technologies concentrate to oxidize the organics in the waste producing a new stream that has its own disposal problems. The need of the hour is to develop close loop technologies which harness the renewable energy and/or nutrient of these waste organics to fuel/or amend the soil. Vermicomposting process is a stabilization of organic waste involving the joint action of earthworms and microorganisms (Khawairakpam and Bhargava, 2009) [8]. Epigeic earthworms have been used as an alternative tool to convert different types of organic waste resource into a product with relatively higher concentration of plant nutrients. Several epigeics (*Eisenia fetida*, *Eisenia andrei*, *Eudrilus eugeniae* and *Perionyx excavatus*) have been recognized as potential candidates to decompose organic waste materials (Manivannan, 2004; Suthar, 2007; Tamizhazhagan, 2016) [3, 9, 10]. However, much work is still necessary to plan a technology with efficient and cost-effective recovery of available wastes into value added product by applying potential local epigeic earthworm resources. With this

background, in the present work were performed to investigate the role of local earthworms *P. ceylanensis* in vermicomposting of PD amended with RH and SPM. Hence, in this work attempt is being done to examine the role of *P. ceylanensis* in bioconversion of poultry droppings and rice husk and its utilization for large scale vermicompost production.

Materials and Methods

Selection of earthworms

Indigenous, efficient epigeic species *Perionyx ceylanensis* (Mich.) were selected for their survival and obtained from the stock culture which was cultivated in cow dung in the laboratory, Department of Zoology, Annamalai University, India. The worms were stocked in cement tank and one month old cow dung was used as substrate to maintain the earthworms.

Collection of organic wastes

Poultry droppings (PD) 7 days old were collected from Indian feeds farm, Perumal kovilmedu, Namakkal district, Tamil Nadu, India. Sugar cane press mud (SPM) was obtained from Thiru Arooran Sugars Limited, located at Tirumandangudi, Thanjavur district, Taminadu, India. Rice Husk (RH) was collected from a modern rice mill, Vandikkara Street, Thanjavur, Tamil Nadu, India. The poultry droppings were transported to the laboratory using sterile plastic bags. PD and SPM were sundried separately for 15 days to remove the odor

and noxious gases.

Experimental design

In the present study, different treatments containing different ratios of poultry droppings (PD) with bulking material Sugar industry press mud (SPM) and rice husk (RH) mixtures were prepared (Table 1). Each was weighed (dry weight) in the above said description and treatments of VCPT1, VCPT2, VCPT3, VCPT4, VCPT5, VCPT6 and VCPT7 were composed of different proportions of PD, RH and SPM with *P. ceylanensis*. The waste mixtures were transferred to separate plastic troughs with 40cm diameter x 60cm depth, respectively. The troughs were filled with 5kg substrate per troughs in above combinations. After transferred in the plastic troughs all the mixture compositions of PD, RH and SPM were allowed for seven days of initial natural decomposition. All the experimental treatments were kept in six replicate for each treatment in a completely randomized block design. Matured earthworms were used in this experiment, with an average weight of 108 to 112mg of *P. ceylanensis* with a developed clitellum. The above treatments were kept under shade and irrigated with equal quantity of water to ensure that the substrate moisture content was maintained at approximately 65-75%. After the completion of pre-inoculation period of 7days, the clitellated *P. ceylanensis* were weighed and inoculated in to respective each treatment (Manivannan *et al.*, 2004) ^[3].

Table 1: Description of different treatments with poultry droppings amended with press mud and rice husk used for vermicomversion.

Treatment No.	Treatment description	proportion
VCPT1	poultry droppings + rice husk	1:1
VCPT2	poultry droppings + Press mud	1:1
VCPT3	poultry droppings + rice husk + Press mud	1:1:1
VCPT4	poultry droppings + rice husk	3:1
VCPT5	poultry droppings + Press mud	3:1
VCPT6	poultry droppings + rice husk	1:3
VCPT7	poultry droppings + Press mud	1:3

Growth and reproduction study

On the basis of collected data of biomass and reproduction, other growth parameters of *P. ceylanensis*, i.e. mean initial biomass (mg), maximum biomass achieved (earthworm⁻¹ mg), biomass gain (earthworm⁻¹ mg), growth rate (earthworm⁻¹ day⁻¹ mg) and reproduction rate cocoon and hatchlings (total number) were produced with the help of recorded data, for different studied treatments of both worms. Mortality rate of *P. ceylanensis* in different treatments also observed during experimentation.

Results and Discussion

The changes in worm biomass, reproduction and mortality of all the treatments for over the experimentation period are shown in Table 2-6. Remarkably *P. ceylanensis* showed significant difference in biomass production and reproduction potential, i.e., maximum biomass achieved at end (mg worm⁻¹), biomass gain (mg worm⁻¹), growth rate (mg worm⁻¹ day⁻¹), total number of cocoon, number of cocoon produced (worm⁻¹), total hatchling number among different treatments. *P. ceylanensis* showed maximum and minimum mean individual

biomass achieved at end in VCPT3 and VCPT4 treatment, respectively. However, *P. ceylanensis* showed significantly higher individual weight in VCPT2 (794±10.5mg) followed by VCPT3, VCPT7, VCPT1, VCPT6, VCPT5 and VCPT4 at the end of experimentation (Table 2). However, net biomass gain (mg worm⁻¹) and growth rate of *P. ceylanensis* in 1:1:1 ratio of PD, RH and SPM and equal proportion of PD and PM treatments was significantly higher than other treatments studied (Table 3). In the present study, maximum biomass in the treatments may be due to the more palatability and acceptability of feed by *P. ceylanensis* and the minimum biomass in the other treatments was possibly due to the occurrence of some growth-retarding substances in it. Hence, the results from the present work, in the context of change in individual weight of worms with the stocking bulk corroborates with the findings of other researchers (Khawairakpam and Bhargava, 2009; Campitelli and Ceppi, 2008) ^[8, 11]. In addition, the growth rate (mg biomass gained/worm/day) has been considered a good comparative index to compare the growth of earthworms in different substrate materials (Kaushik and Garg 2003) ^[12]. Therefore,

the difference in growth rate among different treatments in the present study seems to be closely related to quality of the waste materials. It is also suggested that decrease in weight of worms at high stocking densities may be due to the fatigue of foods below maintenance level in the studied treatments towards the end of vermicomposting.

The total cocoon numbers varied among treatments and maximum and minimum cocoons obtained at the end were in VCPT3 (327 ± 12.5) and VCPT4 (not detected) treatment for *P. ceylanensis*, respectively. In general cocoon production (worm^{-1}) and reproduction rate ($\text{cocoon worm}^{-1} \text{ day}^{-1}$) varied significantly among different treatments ($p < 0.05$). The number of cocoon produced (worm^{-1}) was highest 6.54 ± 0.03 in VCPT3 treatment and minimum 4.24 ± 0.05 recorded in VCPT5, respectively. However, statistically, the difference between VCPT3 and VCPT2 for number of cocoon production (worm^{-1}) was not significant (Table 4 and 5). The maximum reproduction rate was recorded in VCPT2 and VCPT3 (0.08 ± 0 $\text{worm}^{-1} \text{ day}^{-1}$) followed by VCPT7, VCPT1, VCPT6, VCPT5 and VCPT4 treatments. Nonetheless, VCPT2 and VCPT3 treatments did not show a statistically significant difference for reproduction rate (Table 5). Similarly, the maximum number of hatchlings was observed in VCPT2 and VCPT3 treatments for *P. ceylanensis*, respectively (Table 4). Hence the observed results suggested that less content of amendment with PD or RH alone with PD were not suitable for cocoon production. Hence, it may be concluded that production of cocoons in the feed mixtures could be related to

the nutritional quality of the waste, which was one of the vital factors and in addition to the biochemical properties of waste, the microbial population and decomposition rate during vermicomposting are also important in determining the cocoon production (Tripathi and Bhardwaj, 2004^[13]). Nutritional quality of waste may also be the most important for rearing of earthworm on organic waste resources (Suthar, 2007)^[14]. So, the difference in cocoon production could be due to variation in quality of the substrate used in this study. *P. ceylanensis* showed a statistically different pattern of worm mortality among different treatments (Table 6). Nevertheless, difference among 1:1:1 ratio of PD, RH and SPM and equal proportion of PD and PM in treatments, respect to total worm mortality was not statistically significant ($p < 0.01$). The food consumption rate in earthworms during initial critical period, acclimatization of earthworms in waste system also determines the survival of earthworms during vermicomposting. C:N ratio of initial feedstuff may also be a limiting factor the feed consumption rate in earthworms and consequently affects earthworm survival in vermibeds (Kaushik and Garg 2003)^[12] and also concluded that pre-composting is essential to avoid the earthworm mortality. The survival of earthworms in feed mixtures is drastically influenced by the chemical environment and ambient climatic variability. Hence, it has been found that mixing of RH and SPM in PD before vermicomposting reduced the rate of worm mortality during vermicomposting process.

Table 2: Biomass production by *P. ceylanensis* in different treatments of poultry droppings amended with press mud and rice husk used for vermicomposting.

Treatments	Mean initial biomass - worm^{-1} (mg)	Maximum biomass gained at the end - worm^{-1} (mg)
VCPT1	112 ± 3.2	710 ± 12.5^b
VCPT2	108 ± 1.5	794 ± 10.5^d
VCPT3	112 ± 2.3	792 ± 18.2^d
VCPT4	111 ± 4.2	ND
VCPT5	109 ± 3.0	602 ± 12.7^a
VCPT6	111 ± 2.5	712 ± 10.5^b
VCPT7	112 ± 1.5	768 ± 17.8^c

Above values are reported as mean \pm standard deviation among six replicates; values in the same column with diverse letters are significantly different (ANOVA; Tukey's test, $P < 0.05$); ND-Not Detected.

Table 3: Biomass increase and growth rate of *P. ceylanensis* in different treatments of poultry droppings amended with press mud and rice husk.

Treatments	Net biomass gained worm^{-1} (mg)	Growth rate $\text{worm}^{-1} \text{ day}^{-1}$ (mg)
VCPT1	598 ± 7.5^b	8.0 ± 0.3^b
VCPT2	686 ± 6.8^d	9.1 ± 0.5^c
VCPT3	680 ± 10.5^d	9.1 ± 0.3^c
VCPT4	ND	ND
VCPT5	493 ± 7.6^a	7.0 ± 0.4^a
VCPT6	601 ± 6.7^b	8.0 ± 0.4^b
VCPT7	656 ± 9.5^c	8.0 ± 0.5^{bc}

Above values are reported as mean \pm standard deviation among six replicates; values in the same column with diverse letters are significantly different (ANOVA; Tukey's test, $P < 0.05$); ND-Not Detected.

Table 4: Reproduction (number of cocoon and hatchlings) by *P. ceylanensis* in different treatments of poultry droppings amended with press mud and rice husk.

Treatments	Total no. of cocoons	Total no. of hatchlings
VCPT1	267 ± 10.5^b	95 ± 5.6^b
VCPT2	315 ± 20.5^c	120 ± 12.3^d
VCPT3	327 ± 12.5^c	120 ± 10.5^d

VCPT4	ND	ND
VCPT5	212±8.6 ^a	86±6.2 ^a
VCPT6	262±11.5 ^b	91±5.5 ^b
VCPT7	280±10.2 ^{bc}	107±8.4 ^c

Above values are reported as mean ± standard deviation among six replicates; values in the same column with diverse letters are significantly different (ANOVA; Tukey's test, $P < 0.05$); ND-Not Detected.

Table 5: Reproduction rate by *P. ceylanensis* in different treatments of poultry droppings amended with press mud and rice husk.

Treatments	Cocoon production worm ⁻¹	Cocoon production worm ⁻¹ day ⁻¹
VCPT1	5.34±0.04 ^b	0.07±0 ^c
VCPT2	6.30±0.05 ^b	0.08±0 ^d
VCPT3	6.54±0.03 ^b	0.08±0 ^d
VCPT4	ND	ND
VCPT5	4.24±0.05 ^a	0.05±0 ^a
VCPT6	5.24±0.04 ^b	0.06±0 ^b
VCPT7	5.60±0.04 ^{bc}	0.07±0 ^c

Above values are reported as mean ± standard deviation among six replicates; values in the same column with diverse letters are significantly different (ANOVA; Tukey's test, $P < 0.05$); ND-Not Detected.

Table 6: Mortality rate of *P. ceylanensis* in different treatments during experimentation.

Treatments	Treatment description	Ratio	Total mortality after 84 days (%)
VCPT1	poultry manure + saw husk	1:1	17.5±2.0 ^{bc}
VCPT2	poultry manure + Press mud	1:1	2.3±0.5 ^a
VCPT3	poultry manure + saw husk + Press mud	1:1:1	2.5±0.5 ^a
VCPT4	poultry manure + saw husk	3:1	100±0.0 ^d
VCPT5	poultry manure + Press mud	3:1	24.5±2.5 ^c
VCPT6	poultry manure + saw husk	1:3	18.0±0.5 ^{bc}
VCPT7	poultry manure + Press mud	1:3	12.4±1.5 ^b

Above values are reported as mean ± standard deviation among six S replicates; values in the same column with diverse letters are significantly different (ANOVA; Tukey's test, $P < 0.05$).

Conclusion

In this study the vermicomposting of poultry droppings with different ratios press mud and rice husk with *P. ceylanensis* has been studied for its suitability for growth and reproduction. The earthworms did not feed on raw poultry droppings and accepted it as a diet only when press mud and / or rice husk was mixed with it. Among the treatments 1:1:1 ratio of PD, RH and SPM and equal proportion of PD and PM treatment was optimum waste mixtures for the growth and reproduction of *P. ceylanensis* and hence PD can be recommended as feed materials when mixed with appropriate quantity of SPM and RH in vermicomposting process.

References

- Soltani N, Bahrami A, Pech-Canul MI, Gonzalez LA. Review on the physicochemical treatments of rice husk for production of advanced materials. Chemical Engineering Journal, 2015; 264:899-935.
- Shwetha MK, Geethanjali HM, Chowdary K. A great opportunity in prospective management of rice husk. International Journal of Commerce and Business Management. 2014; 7(1):176-180.
- Manivannan S, Ramamoorthy P, Parthasarathi K, Ranganathan LS. Effect of sugar industrial wastes on the growth and reproduction of earthworms. J Exp. Zool. India, 2004; 7:29-37.
- Sen B, Chandra TS. Chemolytic and solid-state spectroscopic evaluation of organic matter transformation during vermicomposting of sugar industry waste. Bioresour Technol. 2006; 98(8):1680-1683.
- The week end leader. Pioneering positive journalism. 2014; 5(24).
- Schiffman SS, Williams CM. Science of odor as a potential health issue. J. Environ Qual. 2005; 34:129-138.
- Moore JR, Daniel PA, Edwards DR, Miller DM. Effect of chemical amendments on ammonia volatilization from poultry litter. J Environ. Qual, 1995; 26:23-26.
- Khwaitrakpam M, Bhargava R. Bioconversion of filter mud using vermicomposting employing two exotic and one local earthworm species. Bioresour. Technol, 2009; 100:5846-5852.
- Suthar S, Nutrient changes and bio dynamics of epigeic earthworm *Perionyx excavatus* Perrier during recycling of some agricultural wastes. Bioresour. Technol, 2007; 98:1608-1614.
- Tamizhazhagan V, Pugazhendy K, Sakthidasan V, Revathi K, Baranitharan M. Investigation of microbial count in the soil and earthworm gut *Eudrilus Eugeniae*. Innovare Journal of Agri Sci. 2016; 4(3):7-9.
- Campitelli P, Ceppi S. Chemical, physical and biological compost and vermicompost characterization: A chemometric study. Chemom. Intell. Lab. Syst, 2008; 90:64-71.
- Jayam MS, Manivannan S. Effect of earthworms activity on humus composition during biological stabilization of coffee pulp amended with pressmud. Int J of Biol Res. 2017; 2(4):137-141.
- Kaushik P, Garg VK. Vermicomposting of mixed solid

- textile mill sludge and cowdung with epigeic earthworm *Eisenia foetida*. Bioresour. Technol, 2003; 90:311-316.
14. Tripathi G, Bhardwaj P. Comparative studies on biomass production, life cycles and composting efficiency of *Eisenia foetida* Savigny and *Lampito mauritii* Kinberg. Bioresour. Technol, 2004; 275-278.
 15. Suthar S. Nutrient changes and bio-dynamics of epigeic earthworm *Perionyx excavatus* Perrier during recycling of some agriculture wastes. Bioresour. Technol. 2007; 98(8):1608-1614.