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ORIGINAL ARETICLE

EFFICIENCY OF *PERIONYX EXCAVATUS* (PERRIER) IN LITTER (*ANACARDIUM OCCIDENTALE* L.) DECOMPOSITION AND NUTRIENT MINERALIZATION

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ABSTRACT

In India, huge amount of cashew leaf litter (CLL), approximately 25-30 Kg. $P^{-1}.Y^{1}$ fall on the soil as solid organic wastes that are not properly utilized/managed. It is intended to test whether these CLL could be used for vermiculture and vermicomposting. Therefore, a series of study were carried out to convert CLL admixed with cowdung (CD) - in to vermifertilizer using indigenous earthworm, *Perionyx excavates* (perrier). The study was to examine the activity of earthworm (growth-biomass, reproduction-cocoon and hatchling number and recovery rate of vermifertilizer) in 100% CD, and admixed with different proportions of CLL (25% 50% and 75%) and the nutrient status of the vermifertilizer (VF) (C/N ratio below 20:1) produced from each treatments (T_1 – T_4). The pronounced and better earthworm activity was found in all treatments (T_1 – T_4), especially more in T_1 (100% CD) and T_3 (50 CD: 50 CLL%) treatments. This seems to be due to rich cellulose, OC, N, P, microbial activity and enhanced water holding capacity. Among the different treatments, VF from T_1 and T_3 treatments showed significant increase in NPK content and decline in pH, OC, C-N and C-P ratio than VF from other treatments. The increased mineralization and conversion of nutrient is due to the biocatalytic role of *P.excavatus* in the decomposition and conversion mechanism. Also increased microbial-enzymatic activities contribute increase in NPK contents in the VF through nitrification, phosphate solubilization and mineralization. Finally, it is concluded that lignocellulosoic solid organic waste resource, cashew leaf litter admixed with cowdung very particularly cowdung at 2:2 ratio may be used for fast bioconversion into a agronomic value added nutrient rich vermifertilizer. This vermifertilizer can also be used as bio-organic fertilizer for maintaining sustainable soil health, fertility, productivity, waste degradation, soil reclamation, land restoration practices and human health.

Keywords: Cashew leaf litter, vermicomposting, *Perionyx excavatus*, vermifertilizer, organic farming.

1.INTRODUCTION

World wide, at present, the organic wastes are used as energy sources. In India, about 3000 million metric tones of organic wastes are produced annually which are disposed by ocean dumping, incineration and land application. The recycling of organic wastes for increasing soil fertility has gained importance in recent year due to high cost of fertilizers and reduced availability of organic manures. Vermicompost application may be a source of nutrient for organic farming practices with several other options, eg. biofertilizer, compost, VAM, BGAK etc. Decomposition of complex organic waste resources into odor free humus like substance through combined action of earthworm and microorganism is called as vermicomposting. The vermicompost of organic wastes results in a product with relatively high content of microbial-enzyme activities, macro-micro nutrients and plant metabolites. Disposal and eco-friendly management of day by day formed organic waste materials from various resources has become a serious global problem. Vermicomposting, a novel technique of converting decomposable organic waste into valuable vermicompost through earthworm activity is a faster and better process when compared with the conventional methods of composting. Vermicomposting of organic waste using epigeic earthworm is one of the recent technique for the recycling of organic wastes and it is a viable, eco-friendly efficient, ecologically sound method for waste management and manure production.

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Cashew tree (*Anacardium occidentale* L.) is one of the most important cash crop of India. Approximately 8 lakhs hectares are planted with this crop giving employment to more 3-4 lakhs people and providing an annual turnover of Rs. 1,985,55 crores. Through socio-economic scenario of our country the cashew tree is very important, but approximately 25-30 Kg of leaf litter is fall on the ground per annum per plant which is not properly managed and/utilized, causing environmental pollution problem and also normal decomposition of this litter takes about 8-9 months due to presence of higher amount of lignin (134g/Kg) and phenol (48g/Kg) contents (Isaac and Nair, 2005). To overcome these problems, cashew leaf litter can be composted and the compost could be used as fertilizer or soil conditioner. Therefore, the present study deals with the quali-quantitative production of vermifertilizer, and growth and reproductive performance of earthworm during vermicomposting of enormously available unutilized organic waste resource – cashew leaf litter admixed with cowdung as bulking material by using predominantly available indigenous epigeic earthworm, *Perionyx excavatus*.

2.MATERIALS AND METHODS

Collection of earthworms, cowdung and cashew leaf litter

Earthworm, *Perionyx excavatus* (Perrier) were obtained from the breeding stocks, Department of Zoology, Annamalai University, Annamalainagar, Tamilnadu, India. Cowdung (CD) was obtained from Agricultural Experimental Farm of Annamalai University, Annamalainagar, Tamilnadu, India. Cashew leaf litters (CLL) were collected from cashew forest, Mutlur, Cuddalore district, Tamilnadu, India.

Preparation of experimental substrates

The cowdung alone and CD admixed with different proportion of CLL in total of 4 treatments were prepared in the following manner:
T_1-cowdung (100%) (1000g), T_2-cowdung + leaf litter (75+25%) (750+250g), T_3-cowdung + leaf litter (50+50%) (500+500g), T_4-cowdung + leaf litter (25+75%) (250+750g) (table 1).

Table 1. Proportion of vermibeds for vermicomposting of solid organic wastes

Treatments	Treatment descriptions	Weight
T_1	CD (100%)	1000 g
T_2	(3:1) CD (75%) + CLL (25%) + with *P. excavatus*	750 + 250 g
T_3	(2:2) CD (50%) + CLL (50%) + with *P. excavatus*	500 + 500 g
T_4	(1:3) CD (25%) + CLL (75%) + with *P. excavatus*	250 + 750 g

CD – Cowdnug, CLL – Cashew leaf litter

The chopped CLL (>3cm) and CD (dry weight) in the above said proportions are mixed well with 62-65% moisture, 65% relative humidity (measured by hygrometer) and 30±2°C. Also, the characteristic features of the raw materials used for experiments are given in the table 2. The organic substrate served as bedding as well as food material for earthworms. The feed mixture were transferred to separate plastic troughs (40cm diameter x 15cm depth) and allowed for 7 days of initial natural decomposition (Parthasarathi, 2007). Experimental bedding were kept in triplicate for each treatment and same another triplicate for each treatment without earthworms served as the experimental control.

Table 2. Characteristic features of the raw materials used for experiment (n=6)

Parameters	CD	CLL
pH	8.03	6.13
OC (%)	27.9	42.79
N (%)	1.09	1.07
P (%)	0.50	0.37
K (%)	0.82	0.28
C:N ratio	26:1	40:1
C:P ratio	56:1	116:1
Dehydrogenase*	4.35	1.32
Lignin (g/kg)	22	193
Cellulose (g/kg)	86	459
Hemicellulose (g/kg)	14	46
Phenol (g/kg)	29	68
Humic acid (mg/g)	6.06	0.42

CD– Cowdnug, CLL – Cashew leaf litter * -μlH/5 g substrate

(Jayanthi *et al.*, 2014)

Earthworms inoculation and their activity

15 grams of sexually immature, preclitellate P. *excavatus* (15-18 days old) (36 numbers) were inoculated into each plastic troughs separately, each trough containing 1 Kg of feed substrate of different proportions (initial 0-day) (Parthasarathi, 2007a). Six replications for each treatment have been maintained upto 60-days. The worms were not fed with additional CLL + CD in the duration of the experiment (60 days). The growth of the worms (biomass in wet weight) were determined before the animals were inoculated into each treatment and thereafter 60th day. The worm biomass(g) were weighed in an electronic balance. The reproductive parameters like number of cocoon production and number of hatchlings were counted on the 60th day by hand sorting (Parthasarathi, 2007a). The vermifertilizer was collected on the 60th day by hand sorting (Parthasarathi, 2004), weighed, and used for determing various quality parameters.

Quality analysis of vermifertilizer

The nutrient contents of the substrates (initial (0-day), worm unworked and worm worked compost) were analyzed by using standard methods. The pH was measured by the method described by ISI Bulletin (1982). Organic carbon was determined by the partially – oxidation method (Walkley and Black, 1934). The total nitrogen content of substrates was analysed according to the method of Jackson 1973 by Macro Kjeldhal method and phosphorus (Olsen *et al*., 1954) and potassium (Standford and English, 1949) were determined by Colorimetrically and Flame photometer methods, respectively. The C:N ratio was calculated by dividing the percentage of carbon in the substrates by the percentage of nitrogen in the same substrates. The C:P ratio was calculated by dividing the percentage of carbon in the substrates by the percentage of phosphorus in the same substrates.

Statistical analysis

The statistical significance between the treatments were tested at 0.05% level of significance using two-way analysis of variance (ANOVA-DMRT).

3.RESULTS AND DISCUSSION

Table 3. Earthworm (P. excavatus) activity during vermicomposting of ca leaf litter admixed with cowdung (P<0.05) (n=6)

Treatments	Biomass (g)		Cocoon production (number)		Hatchling number		Recovery rate of vermicompost (g)	
	Initial (0-day)	Final (after 60 day)	Initial (0-day)	Final (after 60 day)	Initial (0-day)	Final (after 60 day)	Initial (0-day)	Final (after 60 day)
T_1	15.5^a	38.7^b	0	148.6^c	0	224.6^c	0	688.4^b
T_2	15.6^a	36.2^b	0	132.3^b	0	193.8^a	0	667.3^a
T_3	15.4^a	37.5^b	0	141.6^c	0	206.7^b	0	676.6^a
T_4	15.6^a	35.1^b	0	126.7^a	0	182.5^a	0	653.5^a

Mean value followed by different letters is statistically differen

The earthworm activity (*P. excavatus*) – growth and reproductive performance and vermicompost/vermifertilizer recovery during vermicomposting of CLL admixed with different proportion of CD are given in the table 3. Vermicomposting is also considered in terms of production patterns of earthworm biomass, numbers of cocoon, numbers of hatchling and vermicompost. Quality of the organic waste is also one of the factors determining the onset and rate of reproduction (Duminguez *et al*., 2001), and recovery rate of vermicompost (Parthasarathi, 2010). Murchie (1960) proved experimentally the existence of a significant relationship between weight increase and susbtrate type, which may reasonably be attributed to nutritional quality of the susbtrate. Growth and reproduction in earthworms require OC, N and P (Evans and Guild, 1948) which are obtained from litter, grit and microbes (Flack and Hartenstein, 1984; Edwards and Bohlen, 1996; Parthasarathi and Ranganathan, 2000; Parthasarathi, 2010). In the present study, the biomass, number of cocoon production, number of hatchling and recovery rate of vermicompost were highest in T_1, and T_3 treatments than other treatments. *P.excavatus* exhibited highest ($p<0.005$) (table 3) biomass, more cocoon, hatchling and vermicompost production, very particular in T_3. The reasons for the enhanced growth and reproduction in T_3 treatment in the present study seems to be due to : rich cellulose content, microbial population and activity and enhanced water holding capacity (39-41%) which enable the T_3 treatment (50% CD : 50%CLL) to maintain good and ideal moisture. The dependency of earthworm on soil moisture for their survival and activity and on organic matter rich in N for growth and reproduction is well known (Edwards and Bohlen, 1996; Parthasarathi, 2010). The physical structure of the T_3 treatment substrate depends on the chemical composition of the constituents particularly organic matter rich in N; it is only in such type of substrate (vermicomposting medium) that earthworm could reproduce. The T_3 treatment provides such ideal physico-chemical conditions suitable for better growth and maximum reproduction. Hence, it may be concluded that though CLL are nutritionally inferior and slow degrading, the presence of high cellulose in the T_3 treatment develop better water holding capacity and become more palatable and nutritive (rich OC, N, P and microbial population) supporting better growth, reproduction and more compost recovery. Earlier studies of Ranganathan and Parthasarathi (1999), Parthasarathi and Ranganathan (1999; 2000; 2000a; Parthasarathi, 2010) have shown the higher N, P, OC, microbial content of pressmud to support better growth, reproduction and more vermicompost production of *Lampito mauritii*, *Perionyx excavatus*, *Eudrilus eugeniae* and *Eisenia fetida*. This was supported by Edwards and Bohlen (1996), Suthar (2007) who reported that the factors relating to the growth, reproduction and compost production of earthworms may also be considered in terms of physico-chemical and nutrient characteristics of waste feed stocks.

The nutrient quality of vermicompost / vermifertilizer, obtained from CLL admixed with CD in different proportion and their percentage changes over worm-unworked initial substrates (0-days) and the compost are depicted in the table 4. Vermicomposting of CLL in combination with different ratio of CD seems to be advantageous over conventional process of composting. Lowering of pH, in the present study, in the worm-worked compost (vermicompost) at the end of experimentation in all the treatments (T_1 – T_4) was probably due to mucus secretion by the earthworms that had a 'priming effect' on microbial activity, CO_2 and organic acids produced during microbial metabolism (Hartenstein, 1982). It is likely that comparatively lower pH (towards neutral) during vermicomposting was due to additional contribution made by the earthworms. Elvira *et al*. (1998) suggested that production of CO_2, ammonia, NO^{-3} and organic acids by microbial decomposition during vermicomposting lowers the pH of substrate.

The deficiency in OC reduces storage capacity of soil nitrogen, phosphorus, sulphur and leads to reduction in soil fertility (Lee, 1985; Kale, 1988). OC content of vermicompost in the present study indicated that during the process of vermicomposting the level of OC was reduced in the vermicompost obtained from the all treatments (T_1 – T_4) when compared to worm-unworked compost and initial substrates. The results revealed that during the process of vermicomposting the level of OC was reduced to lesser extent in the vermicompost obtained from various treatments and retained the quantity of OC ranging between 21% - 36%. Many earlier investigator have reported and confirmed the reduction of OC content in organic wastes after converted in to vermicompost (Satchell and Martin, 1984; Parthasarathi, 2000; Suthar, 2007). The obtained reduction in the level of OC in the present study falls in line with the earlier reported results.

The main index to assess the rate of organic matter decomposition is the reduction of C-N and C-P ratio during vermicomposting. Carbon to nitrogen ratio is one of the criteria to assess the rate of decomposition of organic wastes and a reduction in the ratio indicates increased rate of decomposition (Edwards and Bohlen, 1996; Suthar, 2007; Parthasarathi, 2010). A similarly reduction in carbon to phosphorus ratio indicates enhanced rate of decomposition (Pore *et al* 1992). Further, plants cannot assimilate mineral nitrogen unless the C:N ratio is 20:1 or lower (Edwards and Bohlen, 1996). Hence the NPK and OC analysis of vermicompost is essential and inevitable to confirm its

Table 4. Nutrient composition of compost and vermicompost obtained from cashew leaf litter admixed with cowdung (P<0.05)

	T_1	T_2	T_3	T_4
pH				
OD	8.03^{a}	10.17^{b}	10.52^{b}	11.61^{b}
WU	7.64^{a}	9.72^{b}	9.68^{b}	9.86^{b}
	(-4.9)^{x}	(-4.4)^{x}	(-8.0)^{x}	(-15.1)^{x}
WW	7.05^{a}	7.14^{a}	7.02^{a}	7.20^{a}
	(-12.2)^{x} (-7.7)^{y}	(-29.8)^{x} (-26.9)^{y}	(-33.3)^{x} (-27.5)^{y}	(-38.0)^{x} (-26.9)^{y}
Organic carbon(%)				
OD	27.9^{b}	30.6^{c}	38.8^{d}	40.6^{d}
WU	21.2^{a}	27.7^{b}	29.3^{b}	36.5^{c}
	(-24.0)^{x}	(-9.5)^{x}	(-24.5)^{x}	(-10.1)^{x}
WW	16.6^{a}	21.3^{a}	19.4^{a}	23.5^{a}
	(-40.5)^{x} (-21.7)^{y}	(-30.4)^{x} (-23.1)^{y}	(-50.0)^{x} (-33.8)^{y}	(-42.1)^{x} (-35.6)^{y}
Nitrogen (%)				
OD	1.09^{a}	1.42^{b}	1.58^{b}	1.34^{b}
WU	1.27^{b}	1.51^{b}	1.81^{c}	1.46^{b}
	(+14.2)^{x}	(+6.0)^{x}	(+12.7)^{x}	(+8.2)^{x}
WW	1.86^{c}	2.17^{d}	2.49^{d}	2.07^{c}
	(+41.4)^{x} (+31.7)^{y}	(+34.6)^{x} (+30.4)^{y}	(+36.5)^{x} (+27.3)^{y}	(+35.5)^{x} (+29.5)^{y}
Phosphorus (%)				
OD	0.50^{a}	0.61^{a}	0.76^{a}	0.58^{a}
WU	0.78^{a}	0.85^{b}	1.16^{b}	0.82^{b}
	(+35.9)^{x}	(+28.2)^{x}	(+34.5)^{x}	(+29.3)^{x}
WW	1.06^{c}	1.28^{c}	1.42^{d}	1.14^{c}
	(+52.8)^{x} (+26.4)^{y}	(+52.3)^{x} (+33.6)^{y}	(+46.5)^{x} (+18.3)^{y}	(+49.1)^{x} (+28.1)^{y}
Potassium (%)				
OD	0.82^{b}	0.71^{b}	0.64^{a}	0.51^{a}
WU	0.91^{b}	0.88^{b}	0.79^{a}	0.65^{a}
	(+9.9)^{x}	(+19.3)^{x}	(+19.0)^{x}	(+21.5)^{x}
WW	1.02^{c}	1.13^{c}	1.27^{d}	1.08^{c}
	(+19.6)^{x} (+10.8)^{y}	(+37.2)^{x} (+22.1)^{y}	(+49.6)^{x} (+37.8)^{y}	(+52.8)^{x} (+39.8)^{y}
C:N ratio				
OD	26:1^{d}	22:1^{d}	25:1^{d}	30:1^{e}
WU	17:1^{c}	18:1^{c}	16:1^{c}	25:1^{d}
	(-34.6)^{x}	(-18.2)^{x}	(-36.0)^{x}	(-16.7)^{x}
WW	9:1^{a}	10:1^{b}	8:1^{a}	11:1^{b}
	(-65.4)^{x} (-47.1)^{y}	(-54.5)^{x} (-44.4)^{y}	(-68.0)^{x} (-50.0)^{y}	(-63.3)^{x} (-56.0)^{y}
C:P ratio				
OD	56:1^{d}	50:1^{d}	51:1^{d}	70:1^{e}
WU	27:1^{b}	33:1^{b}	25:1^{b}	46:1^{c}
	(-51.8)^{x}	(-34.0)^{x}	(-50.9)^{x}	(-34.3)^{x}
WW	16:1^{a}	17:1^{a}	14:1^{a}	21:1^{a}
	(-71.4)^{x} (-40.7)^{y}	(-66.1)^{x} (-48.5)^{y}	(-72.5)^{x} (-44.0)^{y}	(-70.0)^{x} (-54.3)^{y}

value followed by different letters is statistically different; OD – chemical composition of raw materials used in different vermibed (initial 0-day)
al composition of compost proceed without *P.excavatus* (normal compost); WW – chemical composition of compost proceed with *P.excavatus* (vermico
figures in parentheses (+/-) indicates the % increase / decrease over OD; y – The figures in parentheses (+/-) indicates the % increase / decrease o

manureal maturity and quality. The parameters traditionally considered to determine the degree of maturity of compost and to define its agronomic quality is the C:N ratio. According to Morais and Queda (2003), a C:N ratio below 20 is indicative of acceptable maturity, while a ratio of 15 or lower is being preferable for agronomic used of composts. The vermicompost obtained in the present study in all the treatments (T_1-T_4) showed the C:N ratio within the acceptable limit and agronomic preferable as described by Morais and Queda (2003) and that is why, the obtained vermicompost is called as vermifertilizer.

The significant reduction ($p<0.05$) (table 4) and narrow range of C:N ratio below 20:1 and reduction in C:P ratio recorded in the vermifertilizer obtained from all treatments compared to worm-unworked initial substrates and natural compost reflected the high rate of organic matter decomposition, and mineralization thereby resulting in mature and nutrient rich and agronomic value added quality vermifertilizer. The observed significant reduction in the levels of C:N and C:P ratio in the vermifertilizer obtained

from all the treatments were in accordance with the work of Mba (1993), who found that in *E. eugeniae* worked cassava peel compost C:N and C:P ratios decreased. In most of earlier reports a decrease and narrow down of C:N and C:P ratios were recorded in the vermicompost produced from different types of organic wastes (Garg *et al.*, 2005; Suthar, 2007). The reduction in OC and lowering C:N ratio and C:P ratio in the vermicompost could be achieved on the one hand by the combustion of carbon or loss of C as CO_2 during respiration and worm gut microbial utilization (Edwards and Bohlen, 1996) and on the other hand simultaneously enhancement of higher proportion of total N and ionic protein content in the vermicompost due to loss of dry matter (Viel *et al.*, 1987) coupled with the addition of earthworm's activities (i.e., production of mucus, enzymes and nitrogenous excrements (Curry *et al.*, 1995; Parthasarathi and Ranganathan, 2000).

Also, the presence of large number of microflora in the gut of earthworms (Parthasarathi *et al*., 2007) might play an important role in increasing P and K content during the process of degradation of organic wastes thereby decreasing C:P ratio (Parthasarathi, 2010). Enhancement of P and K content during vermicomposting is probably due to the mineralization, solubilization and mobilization of phosphorus and potassium because of earthworm – microbial activity (Parthasarathi and Ranganathan, 1999; Parthasarathi, 2007; 2010). Parthasarathi and Ranganathan's (1999); Suthar's (2007); Parthasarathi's (2007; 2010) investigation support the hypothesis that earthworms can enhance the NPK content during their inoculation in waste system. So from the present finding it can be conducted that the reduction in C:N and C:P ratios of vermicompost indicated enhanced biodegradation process of the organic matter in the different ratios of substrates like cashew leaf letter and cowdung. Further, reduction in C:N and C:P ratios of vermicompost are the indices for the effective biodegradation of cashew leaf litter with cowdung and production of good quality vermicompost with enriched nutrients such as NPK from them.

The significantly ($p<0.05$) (table 4) enhanced levels of NPK in the vermicompost obtained from all the treatments (T_1 – T_4) especially in T_3, (2:2 ratios) over worm-unworked initial substrates and natural compost, in the present study, indicated effective decomposition of cashew leaf litter with cowdung by the combined action of earthworm – microbes. Earthworms enrich the vermicompost with N through excretory products, mucous, enzymes and growth stimulating hormones and even by decaying earthworm tissue after their death. Studies revealed that decomposition of organic material by earthworms accelerates the N mineralization process and subsequently changes the N profile of the substrate (Elvira *et al*., 1998; Benitez *et al*., 2002; Suthar 2007; Parthasarathi 2010). In general, earthworm contains about 60-70% (of dry mass) protein in their body tissue, and this pool of N returned to the soil upon mineralization. Satchell (1967) reported that over 70% of the N in the tissues of dead earthworm was mineralized in less than 20 days. However, decomposition activities and N enrichment by earthworms also depend upon the quality of the substrate material.

After vermicomposting of different ratio of CLL admixed with CD, all treatments showed significantly ($p<0.05$)(table 4) higher concentration of available P in the vermicompost than normal compost and initial substrates. According to Lee (1992) the passes of organic residue through the gut of earthworms, results in phosphorus converted to forms, which are more available to plants. The release of phosphorus in forms available to plants is mediated by phosphatases, which are produced in earthworm's gut (Vinotha *et al*. 2000). Further, release of P may occur by the presence of P-solubilizing microbes in the vermicompost (Parthasarathi *et al*., 2007). Recently, Parthasarathi (2010) reported about 6-8 told increment in available P content in the vermicasts, after inoculation of agro-industrial wastes-pressmud, cowdung and sawdust with earthworms - *Eudrilus eugeniae*, *Eisenia fetida*, *Lampito mauritii* and *Perionyx excavatus.*

After 60 days of vermicomposting, K content increase for different vermibeds was recorded in the order: T_3 (50 & 38%) > T_2 > (37 & 32%) > T_4 (53 & 40%) > T_1 (20 & 11%) treatment. K content in the vermicompost was higher significantly ($p<0.05$) (table 4) than initial substrate material and normal compost. However, when organic waste passes through the gut of earthworm the some quantity of organic minerals are then converted in to more available forms though the action of enzymes produced by gut associated microorganisms. The vermicomposting plays an important role in microbial - mediated nutrient mineralization in wastes. The results of this study agree with previous reports that the vermicomposting process accelerates the microbial populations in the waste and subsequently enriches the vermicompost with more available forms of plant nutrients. Also the present result is similar to those by Parthasarathi and Ranganathan (1999), Parthasarathi (2007; 2010) and Suthar (2007), whose reported enhancement of K content in the vermicompost.

The significantly ($P<0.05$) increased levels of NPK in the vermicompost obtained from the treatment T - T_4 especially in T_3 (2:2 ratio) over worm-unworked normal compost and initial substrates indicated effective decomposition of CLL admixed with cowdung by the combined action of earthworm and microbes. The increased levels of NPK in the vermicompost are in conformity the results of earlier workers. Edwards *et al*. (1985) stated that by the combined action of earthworms and microorganisms on the waste materials most of the N, P, K, Mg were converted in to available form. Kale (1988) reported an increase in the available N, P, K in worm worked CD vermicompost. Parthasarathi and Ranganathan (1999) and Parthasarathi (2000; 2007) reported a significant increase in the level of NPK in *E. eugeniae*, *E. fetida*, *P.excavatus* and *L. mauritii* worked pressmud vermicompost. Hence, from the present study observation 2:2 ratio of CD + CLL could be recommended for vermiculture and production of quality rich vermifertilizer for sustainable agricultural activity in an eco-friendly way besides abating environmental pollution. Also, further study is needed to use various animal dung as bulking material for vermicomposting and develop the integrated system of vermicompostiing method by enhancing the efficiency of indigenous earthworm to overcome the problem of lignocellulosoic waste degradation of organic solid wastes like cashew leaf litter with bioinoculants and produce quality vermifertilizer.

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6.REFERENCES

Benitez, E., H.Saizn, R.Melayar and R.Nogales. 2002. Vermicomposting of a lignocellulosic waste from olive oil industry: A pilot scale study. Waste Management and Research, 20: 134-142.

Curry, J.P., D.Byrne and K.E. Boyle 1995. The earthworm population in winter cereal field and its effects on soil and nitrogen turnover. Biol. Fertil. Soils, 19: 166-172.

Duminguez, J., C.A.Edwards and J.Ashby. 2001. The biology and population dynamics of *Eudrilus eugeniae* (Kinberg) (Oligochaeta) in cattle waste solids. Pedobiologia, 45: 341-353.

Edwards, C.A. and P.J. Bohlen. 1996. Biology and Ecology of Earthworms 3rd Edition. Chapman and Hall. London.

Edwards, C.A., I.Burrows, K.E.Flecher and B.A.Jones. 1985. The use of earthworms of composting farm wastes. In: Composting of Agricultural and other Wastes (Gasser, J.K.R. (ed), Barking, V.K.Elsevier Applied Science Publishers Ltd, pp.229-242.

Elvira, C., L.Sampedro, E.Beritez and R.Nogal Vermicomposting of sludge from paper mill and dairy industries with *Eisenia andrei*: A pilot scale study. Bioresource Technology, 63: 211-218.

Evans, A.C and W J McL, Guild. 1948. Studies on the relationships between earthworms and soil fertility. IV. On the life-cycles of some British Lumbricidae. Ann. Appl. Biol., 35: 471-484.

Flack, F.M. and R.Hartenstein. 1984. Growth of the earthworms, *Eisenia fetida* on microorganisms and cellulose. Soil Biol. Biochem., 16: 491-495.

Garg, V.K., P.Kaushik and N.Dilbaghi. 2005. Vermicomposting of waste water sludge from textile mill mixed with anaerobically digested biogass plant slurry employing *Eisenia fetida*. Ecotoxic and Environ Safe., 65: 412-419.

Hartenstein, R. 1982. Soil macro invertebrate, aldehyde, oxidase, catalase, cellulase and peroxidase. Soil. Biol. Biochem., 14: 387-397.

Isaac, S.R. and M.A.Nair. 2005. Biodegradation of leaf litter in the warm humid tropics of Kerala, India. Soil Boil. Biochem. 37: 1656-1664.

ISI Bulletin. 1982. Manak Bhavan, Bhadur Shah Safar Marg, New Delhi.

Jackson, M.L. 1973. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Jayanthi, L., J.Sekar, S.Ameer Basha and K.Parthasarathi. 2014. Influence of vermifertilizer on soil quality, yield and quality of chilli, *Capsicum annuum*. Online International Interdisciplinary Journal, 4: 206-218.

Kale, R.D. 1988. Annelids (Terrestrial Oligocheates). In: Applied Soil Biology and Ecology (Veeresh, G.K. and Rajagopal, D. (eds), Oxford and IBH Publ. Co. Pvt. Ltd., pp.90-110.

Lee, K.E. 1985. Earthworms: Their Ecology and Relationship with Soil and Land Use. Academic Press. Sydney.

Lee, K.E. 1992. Some trends opportunities in earthworm research or: Darwin's children. The future of our discipline. Soil Biology and Biochemistry, 24: 1765-1771.

Mba, C.C. 1993. Rock phosphatase solubilizing and cellulolytic actinomycetes isolates of earthworm casts. Environ. Management 18: 257-261.

Morais, F.M.C. and C.A.Queda. 2003. Study of storage influence on evaluation of stability and maturity properties of MSW composts. In : Proceeding of the Fourth International Conference of ORBIT Association on Biological Processing of Organics: Advances for a Sustainable Society part II, Perth, Australia.

Murchie, W.R. 1960. Biology of Oligochaeta Biomastos Zetekismith and Gittins in northern Michigan. Am. Midd. Nat., 64: 194-215.

Olsen, S.R., Cole, C.V. Watanabe, F.S. and L.A.Dean. 1954. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. USDA Circ. No. 939.

Parthasarathi, K and L.S. Ranganathan, 1999. Longivity of microbial and enzyme activity and their influence on NPK content in pressmud vermicasts. Eur. J. Soil. Biol., 35: 107-113.

Parthasarathi, K and L.S. Ranganathan, 2000. Aging effect on enzyme activities in pressmud vermicasts of *Lampito mauritii* (Kinberg) and *Eudrilus eugeniae* (Kinbger). Biol. Fertil. Soils, 30: 347-350.

Parthasarathi, K. 2000a. Influence of pressmud on the development of the ovary, oogenesis and the neurosceretory cells of the earthworm, *Eudrilus eugeniae* (Kinberg). Afri. Zool., 35: 281-286.

Parthasarathi, K. 2004. Vermicompost produced by four species of earthworms from sugar mill wastes (pressmud). National Journal of Life Sciences, 1(1): 41-46.

Parthasarathi, K. 2007. Influence of moisture on the activity of *Perionyx excavatus* (Perrier) and microbial – nutrient dynamics of pressmud vermicompost. Iran J. Environ. Health Sci. Eng., 4(3): 147-156.

Parthasarathi, K. 2007a. Life cycle of *Lampito mauritii* (Kinberg) in comparison with *Eudrilus eugenia* (Kinberg) cultured on different substrates. J. Environ. Biol. 28(4): 803-812.

Parthasarathi, K. 2010. Earthworms – Life cycle, Compost and Therapy. Lap Lambert Academic Publishing AG & Co. Germany.

Parthasarathi, K., L.S.Ranganathan, V. Anandi and J.Zeyer. 2007. Diversity of microflora in the gut and casts of tropical composting earthworms reared on different substrates. J. Environ. Biol., 28(1): 87-97.

Pore, M.P., A.S. Charan and S.C.Talashikar. 1992. Effects of fungal cultures on composting of rural residues. Proc. Nat. Sem. Org., Coimbatore, pp.60-61.

Ranganathan, L.S. and K.Parthasarathi, 1999. Precocious development of *Lampito mauritii* and *Eudrilus eugeniae* reared in pressmud. Pedobiologia, 45: 904-908.

Satchell, J.E. 1967. Lumbricidae. In: Soil Biology, (Burges, A. and F.Raw, Eds) Academic Press, London.

Satchell, J.E. and K.Martin. 1984. Phosphatase activity in earthworm faeces. Soil Biol. Biochem., 16: 191-194.

Stanford, D and L.English. 1949. Use of Flame photometer in rapid soil tests of K and Ca. Agron. J., 4: 446-447.

Suthar, S. 2007. Production of vermifertilizer from gum industrial wastes by using composting earthworm *Perionyx sansibaricus* (Perrier). Environmentalist, 27: 329-335.

Viel, M., D.Sayas and L.Andre. 1987. Optimization of agricultural industrial waste management through in-vessel composting in : De Bertoldi, M.(Ed) Compost: Production, Quality and Use. Elsevier Appl. Sci. Essex. pp.230-237.

Vinotha, S.P., K.Parthasarathi and L.S.Ranganathan. 2000. Enhanced phosphotase activity in earthworm casts is more of microbial origin. Curr. Sci. 79(9): 1158-1159.

Walkley, A and I.A.Black. 1934. An examination of the Defijareff method for determining the organic matter and proposed modification of the chromic acid titration method. Soil Sci., 37: 29-38.

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