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ORIGINAL PAPER

Chemical and microbiological changes during vermicomposting of coffee pulp using exotic (*Eudrilus eugeniae*) and native earthworm (*Perionyx ceylanesis*) species

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Abstract Coffee pulp is the main solid residue from the wet processing of coffee berries. Due to presence of anti-physiological and anti-nutritional factors, coffee pulp is not considered as adequate substrate for bioconversion process by coffee farmers. Recent stringent measures by Pollution Control authorities, made it mandatory to treat all the solid and liquid waste emanating from the coffee farms. A study was conducted to evaluate the efficiency of an exotic (*Eudrilus eugeniae*) and a native earthworm (*Perionyx ceylanesis*) from coffee farm for decomposition of coffee pulp into valuable vermicompost. Exotic earthworms were found to degrade the coffee pulp faster (112 days) as compared to the native worms (165 days) and the vermicomposting efficiency (77.9%) and vermicompost yield (389 kg) were found to significantly higher with native worms. The multiplication rate of earthworms (280%) and worm yield (3.78 kg) recorded significantly higher with the exotic earthworms. The percentage of nitrogen, phosphorous, potassium, calcium and magnesium in vermicompost was found to increase while C:N ratio, pH and total organic carbon declined as a function of the vermicomposting. The plant nutrients, nitrogen (80.6%), phosphorus (292%) and potassium (550%) content found to increase significantly in the vermicompost produced using native earthworms as compared to the initial values, while the calcium (85.7%) and magnesium (210%) content found to increase significantly in compost produced utilizing exotic worms. Vermicompost and vermicasts from native earthworms recorded significantly higher functional microbial group's population as compared to the exotic worms. The study reveals that coffee pulp can be very well used as substrate for vermicomposting using exotic (*Eudrilus eugeniae*) and native earthworm (*Perionyx ceylanesis*).

Keywords Coffee pulp · Vermicomposting · *Eudrilus eugeniae* · *Perionyx ceylanesis* · Nutrients · Microbial population

Introduction

Coffee is a perennial crop and is mostly confined to hilly tracts of Western Ghats, the soil erosion and nutrient leaching is the main problem for deterioration of soil physical, chemical and biological properties. In general, coffee requires higher nutrients for its growth and productivity compared to other crops. The availability of organic manures particularly the Farm yard manure (FYM) is a major problem in coffee plantations because of non-availability of

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cattle's, but the FYM can be substituted by application of composts if composting is practiced at on-farm level in coffee farms (Muralidhara et al. 2006). In the present low price situation, coffee growers are unable to invest on chemical fertilizers for their plants, though reduction of chemical fertilizers seems to be positive in environmental view but the required quantity of nutrients removed should be replenished with alternative source.

Coffee pulp and husk are probably the major residues from the handling and processing of coffee. Indeed, about 1 ton of husks are generated during dry processing, whereas for wet and semi-wet processing this residue amounts to more than 2 tonnes (Aranda and Barois 2000). They are lignocellulosic enriched residues that can be used as soil fertilizers, providing a high content of macro- and micronutrients for crop growth and represent a low-cost alternative to mineral fertilizers (Nagaraja et al. 2000; Muralidhara et al. 2006). However, the direct and inappropriately-timed application of these residues to agricultural fields can cause serious environmental problems, including the release of excessive amounts of tannins and phenols in soils, which could inhibit root growth. Therefore, it is necessary to find a suitable methodological alternative to reduce the environmental problems associated with their management (Marnyye et al. 2002). The vermicomposting process is one of the best-known processes for the biological stabilization of solid organic wastes by transforming them into a safer and more stabilized material that can be used as a source of nutrients and soil conditioner in agricultural applications (Paoletti 1999; Lavelle et al. 2006).

Traditionally, coffee pulp and husk had found only a limited application as fertilizers, livestock feed, compost etc. Recently attempts have focused on its application as substrate in bioprocess and vermicomposting (Muralidhara et al. 2006). Vermicomposting is an accelerated process of bio-oxidation and stabilization of the organic matter that involves complex interactions between earthworms and microorganisms (Senapati 1999). Microorganisms are responsible for the biochemical decomposition of organic matter, but earthworms are crucial drivers of the process as they aerate, condition and fragment the substrate, thereby drastically altering the microbial activity (Paoletti 1999; Lavelle et al. 2006). Earthworms act as mechanical blenders and by comminuting the organic matter they modify its physical and chemical status by gradually reducing the C to N ratio and increasing the surface area exposed to microorganisms, thus, making it much more favourable for microbial activity and further decomposition. Efforts to recycle the coffee pulp include activities such as composting (Orozco et al. 1996), feeding to animals, the production of organic fertilizers, single-cell protein and biogas (Rolz et al. 1982; Adams and Dougan 1981; Pulgarin et al. 1991). Application of vermicompost prepared using many organic wastes, has been shown to enhance microbial and enzymatic activities in soils (Lavelle and Martin 1992). But the use of coffee pulp as substrate for vermicomposting has not been well studied in India due to less attention given for soil waste management in coffee plantations. But, recent stringent measures taken by Pollution Control authorities, made it mandatory to treat all the solid and liquid waste emanating from the coffee farms. Hence, vermicomposting surely will come in way for management of coffee pulp in coffee farms for better pollution control and enhancing soil fertility.

In India, there are no studies related to vermicomposting of coffee pulp using earthworms and information of nutrient and microbial dynamics during coffee waste vermicomposting is also lacking. Considering the gravity of the situation and shortage of organic manure and pollution problems in coffee plantations, an experiment was conducted to evaluate the chemical and microbiological changes during vermicomposting of coffee pulp and to compare the efficiency of exotic (*Eudrilus eugeniae*) and native earthworm species (*Perionyx ceylanesis*) on bioconversion of coffee pulp into vermicompost.

Methods

Coffee pulp collection

The coffee pulp for experimentation were obtained from the pulper house of Coffee Research Sub Station, Chettalli, Kodagu, Karnataka (Farm-1) and another two coffee plantations in Kodagu (Farm-2 and Farm-3).

Collection of earthworms

The exotic African earthworms (*E. eugeniae*) were obtained from University of Madras, Tamil Nadu, India, and the native earthworms (*P. ceylanesis*) were isolated from the coffee waste compost pit near pulper house of Coffee Research Sub Station, Chettalli, Kodagu, Karnataka.

Experimental setup/Vermicomposting

Experiments were performed in brick tanks measuring 1 m × 1 m × 0.75 m (length × breadth × depth) with a capacity to hold 500 kg of waste, with a hole at the bottom and overhead shade. Partially dried coffee pulp (10 days old) was used as raw material along with cow dung slurry and FYM as starter. Initially the tanks were smeared with cow dung slurry and filled with a layer of dried coffee husk (15 cm) over which cow dung slurry was sprinkled and weed biomass (10 cm) was spreaded. Partially composted coffee pulp was used as next two layers and sprinkled with cow dung slurry. Third and fourth layer is of partially composted coffee pulp mixed with partially composted weeds. 75% composted coffee pulp with dry FYM was used as fifth layer. Exotic (*E. euginae)* and native (*P. ceylanesis*) earthworms were inoculated separately on the top of the heap at one kg worms per tank. The tanks was covered with gunny bags and the moisture was maintained by periodical sprinkling of water. For subsequent vermicomposting of the predecomposed waste, the earthworms *E. eugeniae* and native earthworms were cultured in cow dung employing the windrow method. There were 3 tanks (3 replicates) each for native and exotic earthworms; a treatment without earthworm inoculation was also included as control. Sampling has been done at initial and at the end of vermicomposting process. The completion of vermicomposting process was judged by visual observation and physical measurement (Sieving) under farmers field. The composting efficiency was calculated based on the quantum of undegraded material left in the tank by sieving method.

Chemical analysis

Vermicompost samples for chemical analysis were drawn at the end of vermicomposting process. The earthworms were removed manually at the end of the experiment and the worm yield and compost yield per tank were quantified separately. Determination of pH was done by a digital pH meter (ELICO- L11 62). Total organic carbon and total Kjeldhal nitrogen were estimated by Walkley and Black rapid titration method (Walkley and Black 1934) and microKjeldhal method, respectively (Singh and Pradhan 1981). Available phosphorus and total potassium were estimated by Bray and Krutz method (Bray and Krutz 1945) and by Flame emission technique, respectively. Exchangeable Calcium and Magnesium were estimated by method as outlined by Jackson, 1973. All the determinations were carried out in triplicate.

Microbial analysis

Samples of 10 g (fresh weight) of vermicompost and vermicasts at the end of vermicomposting process from tanks inoculated with exotic and native worms were serially diluted in 90 ml Ringers solution up to 10^{-4} dilution and 1 ml of aliquot was poured plated in selective media (Nutrient agar for bacteria (Allen 1959), Martin's rose Bengal agar for fungi (Martin 1950), Ken knights and Munaier's agar (Allen 1959) agar for actinomycetes and buffered yeast agar for yeast and the plates were incubated at optimum temperature in triplicates. The functional groups from the soil samples were enumerated using Pikovskaya agar (Pikovskaya 1948) for phosphorus solubilizing microbes (PSM), No. 77 media for *Azotobacter*, Beckings media for *Beijerinckia* (Becking 1959) and Kings-B for fluorescent pseudomonad's (King et al. 1954). The other physiological groups viz., cellulolytic, pectinolytic, starch hydrolytic, proteolytic and chitinolytic microbes were enumerated by following standard microbiological methods (Page 1982).

The microbial colonies appearing after the stipulated time period of incubation were counted as Colony Forming Units (Cfu)/g fresh weight of the sample. The colony characteristics were observed and representative single colonies were isolated and sub cultured on respective media. Cell morphology was observed microscopically after staining. All the bacterial cultures were identified according to Bergey's Manual of Determinative Bacteriology (Holt et al. 1994). Identification of yeast and fungi were done as per the available standard manual (Barnett 1960; Klich and Pitt 1992; Watanabe 1994).

Statistical analysis

All the reported data are the arithmetic means of 3 replicates. Statistical analysis of all the parameters was carried out through analysis of variance (ANOVA) (Gomez and Gomez 1984).

Results and discussion

Chemical and nutrient status of vermicompost

The chemical and microbiological characteristics of coffee pulp used in the experimentation are presented in the Table 1 and the data on nutrient status of vermicompost prepared using exotic and native earthworms are summarized in Table 2. In general, the pH of the vermicomposting material found to fall from its initial value in both the trials with exotic and native worms. The vermicompost which was prepared using native and exotic earthworm recorded a mean pH value of 7.18 and 7.21, respectively, as compared to control treatment (7.18). The lower pH recorded in the final vermicompost might have been due to the production of CO_2 and organic acids by microbial metabolism during decomposition of different substrates in the feed mixtures (Albanell et al. 1988; Chan and Griffiths 1988; Haimi and Hutha 1986; Elvira et al. 1998). Similar results on vermicomposting of cattle manure, fruit and vegetable wastes have been reported by Mitchell (1997) and Gunadi and Edwards (2003). The pH-shift towards acidic conditions is believed to occur because of the resulting higher mineralization of the nitrogen and phosphorus into nitrites/nitrates and the orthophosphates, respectively. This pH shift could also be attributed to the bioconversion of the organic material into other various intermediate species of organic acids (Nedgwa et al. 2000).

Organic carbon found to reduce significantly from the initial value and the decrease was more pronounced with the native earthworm as compared to exotic. The C:N ratio of the coffee pulp after vermicomposting found to reduce significantly with both the worms to the extent of 75% as compared to

Table 1 Chemical and microbiological composition of coffee pulp before vermicomposting

Chemical parameters	
pH	7.6
Organic carbon(%)	53.5
C:N ratio(%)	35.5:1
Nitrogen(%)	1.03
Phosphorus(%)	0.13
Potassium(%)	0.12
Calcium(%)	0.28
Magnesium(%)	0.10
Microbiological parameters (cfu $\times 10^4$/g)	
Bacteria	42.0
Fungi	14.0
Yeast	37.5
Actinomycetes	12.0

Table 2 Nutrient status of vermicompost prepared using exotic and native earthworm

	pH	Organic carbon	C:N Ratio	N	P_2O_5	K_2O	Ca	Mg
Exotic earthworms								
Farm-1	7.23	20.40	9.35	2.35	0.27	0.64	0.53	0.34
Farm-2	7.37	10.47	8.41	1.18	0.47	0.69	0.50	0.30
Farm-3	7.03	13.15	8.42	1.43	0.50	0.78	0.53	0.29
Mean	7.21	14.67	8.73	1.66	0.41	0.70	0.52	0.31
Native earthworms								
Farm-1	7.37	24.96	8.66	2.99	0.65	0.67	0.49	0.23
Farm-2	7.20	10.85	8.41	1.25	0.31	0.89	0.50	0.30
Farm-3	7.43	14.54	9.04	1.33	0.56	0.77	0.53	0.34
Mean	7.33	16.78	8.71	1.86	0.51	0.78	0.51	0.29
Control	7.18	11.24	10.2	1.26	0.32	0.64	0.42	0.25
SE	0.14	0.72	0.206	0.104	0.042	0.03	0.03	0.02
SEd	0.06	0.33	0.09	0.049	0.020	0.014	0.01	0.01
CD ($P = 0.05$)	0.160	0.815	0.236	0.117	0.048	0.035	0.03	0.03

All values are mean of 3 replicates

All the values are given in percentage except pH and C:N ratio

SE Standard error, *SEd* Standard error deviation, *CD* Critical difference

Table 3 Vermicomposting on nutrient status and microbiological properties of coffee pulp

	Chemical parameters								Microbes (cfu × 10^4/g)			
	pH	OC	C:N ratio	N	P	K	Ca	Mg	Bacteria	Fungi	Yeast	Actinomycetes
Coffee pulp (before composting)	7.60	53.5	34.5:1	1.03	0.13	0.12	0.28	0.10	42.0	14.0	37.5	12.0
After composting (exotic worms)	7.21	14.67	8.73:1	1.66	0.41	0.70	0.52	0.31	75.4	21.1	56.2	25.1
After composting (native worms)	7.33	16.78	8.71:1	1.86	0.51	0.78	0.51	0.29	76.4	17.4	64.3	27.0
Control	7.18	11.24	10.2:1	1.26	0.32	0.64	0.42	0.25	51.0	15.2	42.0	16.2
SE	0.14	0.72	0.206	0.104	0.042	0.03	0.03	0.02	0.84	0.11	0.73	0.21
SEd	0.06	0.33	0.09	0.049	0.020	0.014	0.01	0.01	0.39	0.05	0.34	0.10
CD ($P = 0.05$)	0.160 *	0.815 *	0.236 *	0.117 *	0.048 *	0.035 *	0.03 *	0.03 *	0.95 *	0.12 *	0.82 *	0.24 *

All the values are average of 3 replicates

All the values are given in percentage except pH, C:N ratio and microbial counts

SE Standard error, *SEd* Standard error deviation, *CD* Critical difference

* Significant

control (10.2:1) (Table 3). Various studies have shown that earthworms utilize microorganisms in their substrates as a food source and can digest them selectively (Edwards 1988; Edwards and Bohlen 1996). The increase in earthworms' growth may also be attributed to a low C:N ratio (Nedgwa and Thompson 2000). Loss of organic carbon (20–43%) as CO_2 was also observed during vermicomposting of paper mill and dairy sludges (Elvira et al. 1998).

The nutrients, nitrogen (80.6%), phosphorus (292%) and potassium (550%) content found to increase significantly in the compost produced using native earthworms as compared to the initial values, while the calcium (85.7%) and magnesium (210%) content found to increase significantly in exotic worm produced compost. Kaushik and Garg (2004) observed increase in total nitrogen in textile mill sludge along with cow dung and agricultural residues. Decrease in pH may be an important factor in nitrogen retention as this element is lost as volatile ammonia at higher pH (Hartenstein and Hartenstein 1981). Increase in nitrogen content in the final product in the form of mucus, nitrogenous excretory substances, growth stimulating hormones and enzymes from earthworms have also been reported (Tripathi and Bhardwaj 2004). According to Viel et al. (1987) loss in organic carbon might be responsible for nitrogen enhancement. Earthworms also have a great impact on nitrogen transformations in manure, by enhancing nitrogen mineralization, so that mineral nitrogen may be retained in the nitrate form (Atiyeh et al. 2000). However, in general the final N content of compost is dependent on the initial N present in the waste and the extent of decomposition (Crawford 1983; Gaur and Singh 1995). Mansell et al. (1981) observed that plant litter was found to contain more available P after ingestion by earthworms, which may be due to the physical breakdown of the plant material by worms. Satchell and Martein (1984) also found an increase of 25% in P of paper waste sludge, after worm activity. They attributed this increase in P to direct action of worm gut enzymes and indirectly by stimulation of the microflora. The vermicompost has more available nutrients per kg weight than the organic substrate from which it is produced (Buchanam et al. 1988). The biological activity of earthworms provides nutrient rich vermicompost for plant growth thus facilitating the transfer of nutrients to plants (Ismail 2000).

Vermicomposting efficiency and yield

The data pertaining to vermicomposting efficiency and vermicompost yield are presented in Table 4. There found to be significant differences between vermicomposting efficiency of exotic and native earthworms on coffee pulp as compared to control

Table 4 Vermicomposting efficiency and yield

	Days for composting	Compost yield (kg)	Composting efficiency (%)	Earthworm yield (kg)	Worm multiplication (%)
Exotic earthworms					
Farm-1	114.00	356.67	71.24	3.74	274.0
Farm-2	110.67	362.33	72.09	3.47	247.6
Farm-3	111.67	349.33	69.62	4.12	317.0
Mean	112.11	356.11	70.98	3.78	279.5
Native earthworms					
Farm-1	157.00	401.67	80.61	2.46	150.6
Farm-2	165.33	393.33	78.72	2.11	116.3
Farm-3	173.33	371.67	74.64	2.31	135.3
Mean	165.22	388.89	77.99	2.29	134.1
Control	205.00	270.33	54.06	–	–
SE	2.49	5.78	0.387	0.11	2.35
SEd	1.17	2.72	0.182	0.05	1.10
CD ($P = 0.05$)	2.82	6.54	0.438	0.11	2.41

All values are mean of 3 replicates

SE Standard error, *SEd* Standard error deviation, *CD* Critical difference

treatment. Exotic worms found to degrade the coffee pulp faster (112 days) as compared to the native worms (165 days). The control treatment without earthworm inoculation took 205 days for complete degradation of coffee pulp. Native worms took 53 days excess to that of exotic worms to complete the vermicomposting process. However, the compost yield found to significantly higher in case of native worms. The multiplication rate and worm yield recorded significantly higher with the exotic earthworms and it was almost double the population as compared to native earthworms. Use of vermicomposting technology in coffee waste management have been reported by many workers in coffee producing countries (Aranda and Barois 2000; Marnyye et al. 2002; Nogales et al. 2005). Suthar (2006, 2007) have reported production of vermifertilizer from guar gum industrial wastes by using composting earthworm *Perionyx sansibaricus* (Perrier), while Benitez et al. (2002) reported production of vermicompost from olive oil industry waste.

Microbiological parameters

The data on general and functional microflora of vermicompost prepared using exotic and native earthworms are presented in Table 5. In general microflora, except fungi, found to be significantly higher in compost prepared using native worms as compared to exotic species. Similar is the case with functional microbial groups, vermicompost prepared using native earthworms recorded significantly higher counts as compared to the exotic worms. Kristufek et al. (1992) have reported that the number of bacteria, microfungi, and micromycetes increased in the guts of *Lumbricus rubellus* while Edwards and Burrows (1998) have reported that vermicompost was richer in fungi, bacteria, and actinomycetes compared to the soil. This could be attributed to the fact, as reported by Pedersen and Hendriksen (1993) that in the guts, there could have been an increase in the number of vegetative cells as well as germination of the spores of this bacterial community due to an increase in nutrient availability by the release of nutrients from ingested material.

The data on microbiological properties of vermicasts from exotic and native earthworms are summarized in Table 6. Bacteria, fungi and yeast population found to significantly higher in the vermicasts from the native earthworms as compared to exotic, while the actinomycetes counts found to significantly higher with the vermicasts of exotic worms. Vermicasts are rich sources of macro and micronutrients, vitamins, enzymes, antibiotics, growth hormones and immobilized microflora (Kale et al. 1987). The nutrients present in vermicasts are readily soluble in water for the uptake of plants (Bhawalkar and Bhawalkar 1993). Syers and Springett (1984) found an increase in the number of bacteria and actinomycetes with enhanced

Table 5 Microbiology of vermicompost prepared from coffee pulp

	General microflora (cfu × 10^4/g)				Functional/Physiological groups (cfu × 10^3/g)							
	Bacteria	Fungi	Yeast	Actinomycetes	N_2 fixers (free living)	P-Solubilisers	Fluorescent Pseudomonads	Cellulolytic	Pectinolytic	Starch hydrolytic	Proteolytic	Chitinolytic
Exotic worms												
Farm-1	83.0	23.7	61.3	26.0	11.7	7.3	12.0	7.0	15.7	8.0	3.0	1.7
Farm-2	75.3	24.0	53.0	25.7	8.3	5.0	12.7	8.3	19.7	10.7	5.0	1.7
Farm-3	68.0	15.7	54.3	23.7	6.0	5.3	14.3	9.7	19.0	11.3	5.3	2.3
Mean	75.4	21.1	56.2	25.1	8.7	5.9	13.0	8.3	18.1	10.0	4.4	1.9
Native worms												
Farm-1	67.0	18.3	62.0	23.7	8.7	4.7	14.3	9.7	21.3	15.7	8.0	2.7
Farm-2	80.7	17.0	69.3	27.0	12.0	7.0	19.0	10.7	20.3	12.0	6.7	2.7
Farm-3	81.7	17.0	61.7	30.3	10.7	7.3	21.3	9.3	19.7	8.7	9.0	4.0
Mean	76.4	17.4	64.3	27.0	10.4	6.3	18.2	9.9	20.4	12.1	7.9	3.1
Control	51.0	15.2	42.0	16.2	3.9	3.0	9.40	5.4	14.0	5.5	2.8	1.6
SE	1.18	0.39	1.10	0.42	0.30	0.21	0.80	0.25	0.55	0.23	0.30	0.21
SEd	0.55	0.18	0.51	0.19	0.14	0.10	0.37	0.12	0.26	0.11	0.14	0.10
CD ($P = 0.05$)	1.34	0.45	1.24	0.47	0.34	0.24	0.91	0.28	0.62	0.26	0.34	0.24

All the values are average of 3 replicates

SE Standard error, *SEd* Standard error deviation, *CD* Critical difference

Table 6 General and functional microflora of coffee pulp vermicasts

	General microflora (cfu × 10^4/g)				Functional/physiological groups (cfu × 10^3/g)							
	Bacteria	Fungi	Yeast	Actinomycetes	N_2 fixers	P-solubilisers	Fluorescent pseudomonads	Cellulolytic	Pectinolytic	Starch hydrolytic	Proteolytic	Chitinolytic
Exotic worms												
Farm-1	165.3	31.3	127.7	38.0	14.7	11.0	22.7	16.0	38.3	18.0	7.3	4.7
Farm-2	148.3	34.0	123.3	42.0	13.7	12.0	17.3	12.7	34.0	27.3	9.7	6.3
Farm-3	134.7	39.7	118.0	33.0	8.30	12.0	20.0	13.7	32.3	17.7	7.0	4.7
Mean	149.4	35.0	123.0	37.7	12.2	11.7	20.0	14.1	34.9	21.0	8.0	5.2
Native worms												
Farm-1	185.7	25.7	132.3	23.7	14.3	8.0	28.3	12.0	43.3	25.3	5.0	5.3
Farm-2	181.7	31.3	152.7	43.3	16.0	16.0	28.3	18.7	36.0	34.3	7.3	4.7
Farm-3	164.0	48.7	132.3	37.0	20.0	15.0	34.7	18.3	32.7	33.3	12.3	4.0
Mean	177.1	35.2	139.1	34.7	16.8	13.0	30.4	16.3	37.3	31.0	8.2	4.7
Control	120.6	16.3	98.60	16.4	5.80	5.50	14.4	8.0	21.2	12.5	3.6	2.4
SE	0.425	0.271	0.455	0.261	0.186	0.241	0.395	0.334	0.525	0.337	0.175	0.195
SEd	0.20	0.12	0.21	0.12	0.08	0.114	0.186	0.157	0.247	0.159	0.08	0.09
CD ($p = 0.05$)	0.481	0.307	0.515	0.296	0.210	0.273	0.447	0.378	0.594	0.382	0.198	0.220

SE Standard error, *SEd* Standard error deviation, *CD* Critical difference

All the values are mean of 3 replicates

phosphatase activity in earthworm casts. Earthworm gut is having many beneficial microbes including polymer degraders, phosphorus solubilizers, and nitrogen fixers. In functional microbial groups, except chitinolytic microbes all other microbes found to significantly higher with the vermicasts of native worm. Gopal et al. (2009) has reported similar results on the occurrence of beneficial microflora in vermicompost prepared from coconut leaves. Vermicompost not only increase the soil fertility through the addition of plant growth hormones and increased levels of soil enzymes (Chaoui et al. 2003); they are also responsible for the dissemination of important microorganisms as they are rich in microbial diversity, population, and activity (Kale et al. 1992; Subler et al. 1998).

Conclusion

The present study clearly proved that coffee pulp can be very well used as substrate for vermicomposting using native and exotic earthworm species. The data from this study provides a sound basis that vermicomposting is a suitable technology for onfarm bioconversion of coffee pulp into value-added compost and reduction of solid waste pollution in coffee growing regions of India. Analysis of chemical and microbiological properties of vermicompost obtained from coffee pulp clearly indicates the enhancement in nutrient value and microbiological quality of compost and its utility as a good source for plant nutrients and soil fertility enhancement in coffee plantations.

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