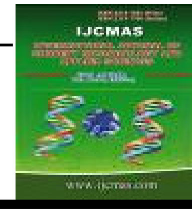

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Original Research Article

Bioconversion of Organic Waste Using *Perionyx ceylanensis* and enhances performance of microorganisms on Black Gram (*Vigna munga* L.Heeper)

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A B S T R A C T

Keywords

Perionyx ceylanensis, vegetable waste, Vermi-stabilization, Black gram (*Vigna mungo L. Hepper*)

The Quality of the vegetable waste (orgnic waste) before and after 60 days of vermicomposting was investigated on Physico-chemical and microbiological methods. Vermistabilization of vegetable waste by using Epigeic species of *Perionyx ceylanensis* by using cow dung as the supporting material. The bulk density on 0th day in vegetable waste with cow dung incorporated sample were higher than the control. The chemical analysis of N, P and K also showed increasing trend on 60th day of composting than the initial 0th day and control sample. The total bacterial count on the 60th day of composting with cow dung incorporated vegetable waste tremendously higher than the 0th day and control sample under investigation. The plant growth parameters Shoot length, root length, and Number of root nodules and also yield of Black gram (*Vigna mungo L. Hepper*) was determined.

Introduction

Vermicomposting is the process by which worms are used to convert organic materials (usually wastes) into a humus-like material known as vermicompost. The goal is to process the material as quickly and efficiently as possible. earthworms. The goal is to continually increase the number of worms in order to obtain a sustainable harvest. The worms are either used to expand a vermicomposting operation or sold to customers who use them for the same or other purposes. If the goal is to produce vermicompost then procured maximum worm population density all of the time. If the goal is to produce worms then we keep the population density low enough so that reproductive rates are optimized (Edwards, 1988; Edwards and Bohlen, 1996).

Earthworms improve the aeration of soil by their burrowing activity. They also influence the porosity of the soil. Earthworms are observed to improve the nature of soil by breaking up organic matter and increasing the amount of microorganism made available to plants. The stability of biopores increases with pore diameter and with more nearly vertical orientation of pores. Many of the microorganisms are transported by earthworms are those involved in the decomposition of organic materials.

An important waste that emerges out from Vegetable market leads to foul odour, environmental pollution, soil sickness and ground water pollution (Abbasi and Ramasamy, 1999). Epigeic earthworms have the potential to convent organic wastes into valuable vermicompost for plant growth and vermiprotein for use as animal feed in poultry and aquaculture.

The growth of industries and ever increasing human population has led to an increased accumulation of waste materials (Joshi and Chauhan, 2006). Vegetable wastes are one of the major sources of municipal wastes. Recycling of wastes through vermitechnology reduces the problem of non-utilization of wastes. Alternative to chemical fertilizers, locally available organic wastes of anthropogenic and natural products were used as biofertilizers after employing earthworm as decomposers, for degradation and recycling to enhance the production of crops which are free from pollution and health hazard (Bakthvathsalam and Ramakrishnan, 2004).

Vermicompost has higher economic value compared with compost derived from traditional methods. Vermicompost are finally divided peat like materials with high porosity, aeration, drainage and water holding capacity. Vermicomposts contain in nutrients in forms that are readily taken up by the plants.

Perionyx ceylanensis is an epigeic earthworm species with a short life cycle, recently explored for its potential in vermicomposting and the effect of vermicompost on plant growth and yield (Karmegam and Daniel, 2008;Karmegam and Daniel, 2009a, 2009b). *P. ceylanensis* is a purple–red coloured epigeic earthworm, mainly found in biogas slurry, dung pats, composting heaps and decomposing leaf litter heaps The study on the vermistablisation of mango (*Mangifera indica* L.) leaf litter with *Eudrilus eugeniae* and *Eisenia fetida* shows the possibility of producing vermicompost from these organic residues (Gajalakshmi et al.,2005).

In view of this, an attempt has been made in the present study deals with vermiculturing and earthworm interaction microflora, physical, chemical parameters of vermicompost material and influence of plant growth on black gram (*Vigna mungo L. Hepper*).

Materials and Methods

Collection of Materials

Vegetable wastes were collected from market shop of Kancheepuram, Tamil Nadu and subjected to initial decomposition in rectangular draining cement tanks of 75cm×60cm×45cm size by sprinkling water, regular mixing and turning of the substrates for 15 days. The cowdung (CD) was collected from nearby cattle sheds in fresh form and allowed to stabilize for one week and used for the study. The stabilization of cowdung was done to make it acceptable by the worms.The earthworm, *P. ceylanensis* for the study, originally collected from culture bank of the Department of Biology, Gandhigram Rural University, Tamilnadu was mass multiplied in cowdung and used for the study.

Vermicultural Tub Treatment Process

Vegetable waste were mixed with standard bedding material and introduced into standard plastic tubs occupying about 3kg of the materials. The each predecomposed substrates were mixed with cow-dung in 1:1 ratio on dry weight basis in separate plastic trays of 45cm x 35cm x 15cm size with six replicates for a period of 2 months. Vermicomposting was carried out in an environmentally controlled experimental chamber at a temperature of 27±1°C and the vermibeds were maintained to contain a moisture level of (65-75%) by sprinkling water over the surface daily. Each tray containing vermibed substrate was introduced with 60 adult Epigeic species of Earthworm *P. ceylanensis* were inoculated manually in selected bedding materials in plastic tubs. The culture tubs were placed Indoor in the laboratory. The bedding material upper surface was covered with wire mesh to avoid entry of predators.

Sample Collection and Processing

The samples for analysis were taken out from the vermicomposting plastic tub at the start of the experiment, then after 15 days, 30 days, 45 days and lastly, after 60 days. That is, a time interval of fifteen days was taken as the standard for taking out the samples.

Nutrient Analysis

Samples from vermibed substrates and vermicompost were dried, ground and sieved. The pH and electrical conductivity were determined by the method of Jackson (1973) in distilled water solution. Moisture was determined by heating a sample of known weight (5 g) placed in a moisture bottle, till constant weight in an electric oven at 70°C, and deducting the loss in weight. The determination of organic carbon was carried out as per the procedure of Walkley and Black (1934); total nitrogen, phosphorus, potassium, sodium, calcium, magnesium, sulphur, copper, zinc, iron and manganese were determined according to standard methods as described by Jackson (1973) and Tandon (1993); C/N ratio was calculated by dividing the percentage of carbon estimated for the sample by the percentage of nitrogen estimated for the same sample; the same procedure was used to estimate C/P ratio. The percent increase/decrease of various physico-chemical (nutrient) parameters over the worm-unworked substrates was calculated [(A B/A) × 100; where A = values in the wormworked substrate, B = values in the wormunworked substrate].

Microbiological Analysis

One gram of each sample was transferred to test tubes containing sterilised water and serial dilutions were made. This was used as inoculum and 1.0 ml was transferred to Petri plates containing Nutrient agar media, Rose Bengal agar and Kenknight s media respectively for the enumeration of bacteria, fungi and actinomycetes in triplicate and incubated for 24 hrs, 72 hrs and one week respectively. At intervals, colony-forming units (CFU) were determined by making total counts on the incubated plates using a colony counter.

Experimental work for Plant Growth

In this experiment, three treatments were tested with Black gram (*Vigna mungo L. Hepper*).

T0 – Red Soil (Control - Farmer's practice)
T1 – Vermistabilised Vegetable waste

The above treatments were replicated thrice in a randomized block design with inoculated vermistabilised vegetable waste substrates. The unit plot size was 2.5cm x

2cm. Plants were grown in plots for 12 weeks. Weeding, irrigation, drainage, crop protection and other intercultural operation were done when necessary. The soil was moistened with water and maintained at 60% of its moisture. The criteria for growth promotion was studied as root, shoot length and other parameters. Data on growth, yield and yield contributing parameters were recorded.

Physiological Observations

Shoot Length

At sampling periods, the seedlings of Black gram (*Vigna mungo L. Hepper*) were plucked out from the plot carefully and washed with tap water to remove the adhering soil. Shoot length was measured from the base to the tip of the lengthiest shoot.

Root Length

At Sampling Periods; their seedlings of Black gram (*Vigna mungo L. Hepper)* were pulled out from the plot carefully without breakage of roots. Root length was measured from the base to the tip of the lengthiest root.

Number of nodules

The total numbers of nodules were counted numerically to find out the influence of plant growth promoting bacteria and organics on the root growth.

Yield of Black gram Plant:

The total number of flowers, number of pods and number of seeds present in the each pod were counted numerically to find out the black gram yield for the influence of microorganisms and organic substrates.

Results and Discussion

Physico-Chemical Characteristics of Vermicomposting

Table 1 shows the Physico – chemical characteristic of Vegetable waste during 60 days at composting using *P. ceylanensis* with control as comparative sample. The pH of the sample gradually increased from 6.5 to 7.8. The bulk density was reduced from 0.66 to 0.50. The pore space, moisture content and electrical conductivity (EC) showed an increasing trend from 62.05 to 73.52%, from 56.4 to 62.3 and from 1.16 to 1.32 respectively. The chemical analysis of the vegetable Waste increase in the levels of N, P, K, Ca, Mg, Fe, and Zn.

Table 2 shows the total microbial population count during the process of vermicomposting with reference to the control. The microbial load showed on 0^{th}, 15^{th}, 30^{th}, 45^{th}, and 60^{th} day. The vermicompost of *P. ceylanensis* worked compost showed maximum population of bacteria, fungi and actinomycetes whereas in control decreased number of microbial population (Figures .1,2 & 3). Total microbial population count in the Earthworm gut on the initial day i.e 0^{th} day and final day i.e 60^{th} day. The earthworm gut load was also found to be in an increasing order.

Physiological parameters analysis

The results on the effect of inoculation of Vermicompost along with an uninoculated control in black gram (*Vigna mungo L. Hepper*) have been presented the data in Table 5 and 6.

Root Length

All the treatments were significantly

increasing their efficiency on the growth of roots. Here, this experiment showed the best performance of T1 (22.5) than T0 as control having 22 cm in 90th day of plant growth.

Shoot Length

This simple experiment was conducted to find out the effect of vermicompost which increased the shoot length over uninoculated control. In this experiment, T1 (39cm) show best performance than T0 as a control (32cm).

Number of Root Nodules

All the treatments were significantly increasing their efficiency on the root nodules of black gram (*Vigna mungo LHepper*) plant. Here, this experiment showed the best performance in T1compare to control (T0).

Effect of Vermicompost on the yield of black gram (*Vigna mungo L. Hepper*)

The number of main parameters on the yield of black gram was significantly influenced by application of vermicompost treatments (Table.6). The number of flower per plant ranged form 2 to 10. The highest number of pods (22) produced per plant by the application of vermicompost on the 90th day. The highest number of seeds present per pod of plant by the application of vermicompost is 8 than T0 control.

Table.1 Physico - chemical characteristic of vegetable waste during the composting period using the *P. ceylanensis* on comparison with control sample

S.No.	Parameter	Vegetable waste		
		Initial	Final	Control
1	pH	6.53	7.80	6.80
2	Electrical conductivity(ds/m)	1.16	1.32	1.10
3	Bulk density	0.66	0.50	0.60
4	Pore space (%)	62.05	73.52	63.20
5	Moisture content (%)	56.4	62.3	56.8
6	Organic Carbon	28.48	25.6	27.89
7	Nitrogen %	1.20	1.96	1.16
8	Phosphorus %	3.25	4.39	3.11
9	Potassium %	1.40	1.80	1.10
10	Calcium (%)	2.30	3.13	2.15
11	Magnesium (%)	0.46	0.67	0.44
12	Iron(ppm)	184.0	199.0	180.0
13	Copper(ppm)	17.0	19.0	12.0
14	Zinc(ppm)	61.0	63.0	56.0
15	C/N ratio	23.73	13.06	24.03
16	C/P ratio	8.76	5.83	9.00

Table.2 Total Microbial population count during the process of vermicomposting with reference to the control

S.No	Type of Microbes	Type	Interval (In days)				
			0	15	30	45	60
1	Bacterial count	Control	40	50	60	75	86
		Vegetable waste	49	80	120	140	198
2	Fungal count	Control	31	43	45	55	59
		Vegetable waste	50	72	85	96	120
3	Actinomyces count	Control	26	30	37	40	42
		Vegetable waste	29	45	63	76	80

Table.3 Effect of Vermicompost on plant growth parameters* of Black gram *(Vigna mungo L. Hepper)*

Treatment	**No. of days**	**Shoot length (cm)**	**Root length (cm)**	**No. of Root nodules**
T0	**15**	**7.2**	**3.5**	**0**
T1		**8.8**	**4.8**	**0**
T0	**30**	**14.5**	**8**	**13**
T1		**14.8**	**9**	**15**
T0	**45**	**18.8**	**11.9**	**14**
T1		**21.2**	**13.5**	**22**
T0	**60**	**21.8**	**16.2**	**14**
T1		**24**	**18**	**22**
T0	**75**	**25.8**	**19.6**	**15**
T1		**32**	**20.4**	**22**
T0	**90**	**32**	**22**	**15**
T1		**39**	**22.5**	**22**

T0 = Red Soil; T1 = Vermicompost *Mean of Three replications,

Figure.1 Bacterial Population on vegetable waste (worm worked and worm unworked)

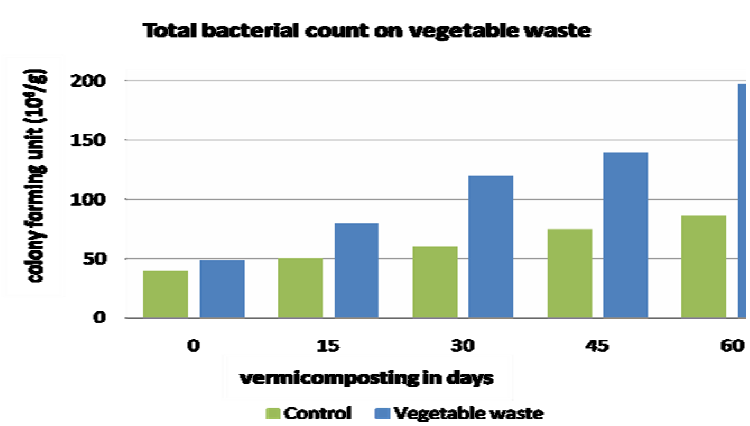


Table.4 Effect of vermicompost on the yield of Black gram (*Vigna mungo*)

Treatment	No. of days	No of Flowers	No of pods Per plant	No of seeds Per pod
T0	15	-	-	-
T1		-	-	-
T0	30	-	-	-
T1		-	-	-
T0	45	0	0	0
T1		2	0	0
T0	60	6	2	5
T1		8	6	8
T0	75	7	6	6
T1		8	12	8
T0	90	6	16	8
T1		10	22	8

Figure.2 Fungal Population on vegetable waste (worm worked and worm unworked)

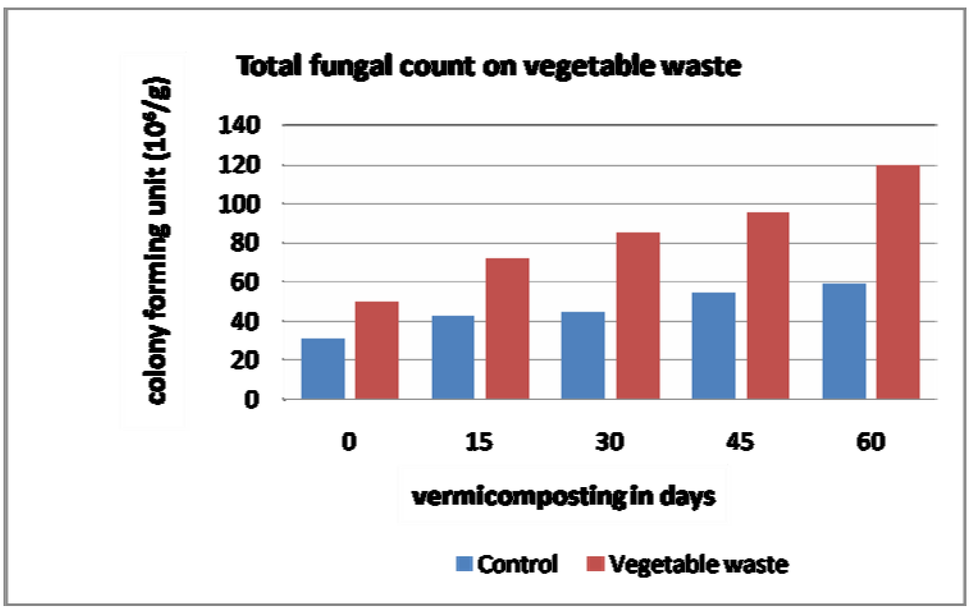
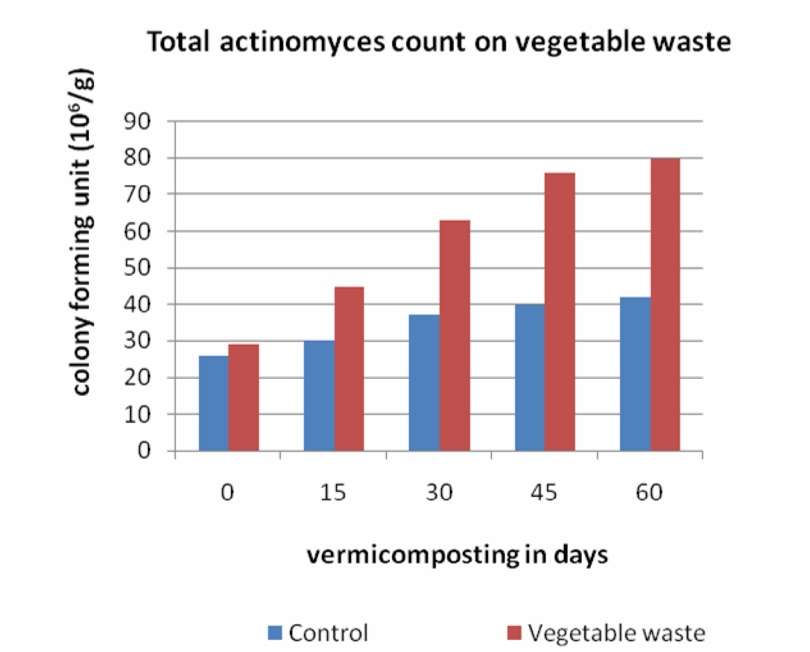


Figure.3 Actinomyces Population on vegetable waste (worm worked and worm unworked)



Vermiculture has received considerable attention in recent years internationally for its immense potential in recycling biodegradable waste in popularizing organic farming. Certain species have been identified to be very useful in degradation of organic wastes, viz., *Eisenia fetida*, *Dendrobaena venata* and *Lumbricus rubellus* from temperate areas and *Eudrillus eugeniae* and *Perionyx excavates* from the tropics (Edwards, 1998).

Population dynamics, productivity and energy flow in earthworms cannot be fully understood unless the lifecycle of earthworm is known. Studies on the life cycle of earthworms are also necessary for effective vermiculturing (Bhattacharjee and Chaudhuri, 2002).

An important observation was showed in the physico-chemical characteristics of Vegetable waste+CD (1:1) substrates subjected to vermicomposting with *P. ceylanensis* for 60 days showed changes in nutrient contents. (Table 1). Similiar report also observed in Prakash and Hemalatha (2013) in earthworm species - *Eisenia fetida.* In this, the physico-chemical characteristics such as E.C., NPK, Ca, Mg, Fe and Cu in Vegetable waste (1:1) vermicompost showed increase over worm unworked substrates. Whereas pH, OC, Na, Mn, S, Zn, C/P and C/N in the vermicompost of vegetable waste (1:1) showed decrease over worm unworked substrates The parallel results have also been reported by Ramalingam and Ranganathan, (2001); Prakash, *et al*.(2008); Prakash and Karmegam (2010), Prakash and Hemalatha (2013).

Therefore, biological treatment methods have received much attention and considered as efficient, low cost treatment for oranic waste. The worms along with organic manure's can be utilized as an alternative to costly inorganic fertilizers (Senappathi, 1980).

The findings of the present study thus confirm the concept that the earthworm gut might be a specialized microhabitat of enhanced microbial activities in soils (Karsten and Drake 1995). Lee (1985) suggested that the increase in microbial population in the gut of earthworms might be due to the utilization of additional nutrients available as a result of enzymatic breakdown of ingested materials. In the present study, the high nitrogen and moisture contents recorded in the earthworms guts may also have contributed to this by stimulating microbial activity.

The growth of the Black gram (*Vigna mungo* L. Hepper) was enhanced due to the application of with Vermicompost. In the present experiment, the results revealed a beneficial effect of Plant growth on the black (*Vigna mungo*). Similar observations were made by Ramanathan (1986) clearly indicated that to obtain healthy seedlings. The germination and seedling biomass of Green gram (*Vigna radiata*) was increased by organic inputs. The effect of organic manures integrated with NPK chemical and yield parameters of press mud with vermicompost recorded higher yield.

The effect of vermicompost reflected in shoot, root length and root numbers in the investigation made in this study experiment. The highest shoot, root length and number of root nodules were obtained in vermicompost in this experiment (Table.3 and 4).

The field trial has shown that vermicompost increased the plant growth when compared the control (T0) i.e., red soil (Table.3 and 4). All these observation showed that vermicompost can form a increased rate of plant growth, thereby reducing the cost of crop production, improving soil fertility and saving the environment form the ill effects of chemical compounds. The nutrient uptake (NPK) by plants and seeds yield was higher with vermicompost application and decrease amount in normal soil application. Similar results for *A. hypogeal* and *V.mungo* were reported by Parathasarathi and Ranganathan (2001).

The findings of the present study reinforce the general concept that the gut and casts of earthworms tend to be much more microbiologically active than the surrounding soil. Enhancing the growth of these soil organisms can serve as a basis for the development of living soils by optimizing the potentials of the beneficial biotic populations identified in this work.

The study clearly indicates that the vermicompost in respect of organic substrates and earthworm species utilized had increased amount of plant growth when compared control (T0) i.e red soil. The long run effect of similar application trials are required to completely justify the improvement of soil fertility status.

In conclusion, vermicomposts have the potential for improving plant growth when added to greenhouse container media or soil. The optimal plant growth in our study, which was conducted only over a short period of time, was in pots containing pig manure vermicompost or composted biosolids. This result also showed distinct differences between specific vermicomposts and their nutrient contents, the nature of their microbial communities, and their effects on plant growth.

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