

## Vermicomposting of Food Waste Using Exotic Species of Earthworms “*Eudriluseugeniae*” at Mangalagangothri.

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### Abstract

A study has been conducted to assess the role of vermicomposting and carrying out plant nutrients analysis of composts delivered from food waste at Mangalagangothri campus, Dakshina Kannada District, Karnataka-India. Wastes were collected and subjected to pit- and vermi-composting using an exotic species of earthworm (*Eudriluseugeniae*). The composts were harvested and analyzed for macro-nutrients (N, P, K, Mg, Ca, S) by employing the standard methods. The Bioassay was conducted using *Pisumsativum*L. plant and the data were analyzed statistically using SPSS. 20. Results revealed that there was highly reduction in the volume of the wastes equivalent to 30% and 20% for vermi- and pit-composting respectively. The macro-nutrients analysis showed that vermicompost had more nutrients than pit-compost. Based on bioassay test, the vermicompost had the potential for improving plant growth and yield compared to pit-compost and garden soil (control). Thus, vermicompost was found to be cost-effective methods, helps in reducing food waste disposals and supplied soil with a lot of macro-nutrients compared to that of the pit-compost based on results of bioassay and nutritional parameters.

**Keywords:** Bioassay; *Eudriluseugeniae*; Food waste, *Pisumsativum*, Vermicompost.

### 1. Introduction

Municipal solid waste (MSW) management including food waste has become one of the most significant challenges urban and suburban areas are facing today due to the enormous amount of waste produced day per day (Vidyasagaran and Kumar, 2017). Its poor disposal can lead to the increased environmental pollution and degradation (Pierre and Prashantha, 2016). The safe, cost effective and very environmental friendly management method is the recycling through vermicomposting (Sharma *et al.*, 2011, Parfitt *et al.*, 2010).

Vermicomposting is a modified and specialized method of composting; the process uses earthworms and microorganisms to disintegrate, eat and digest organic wastes and turn out end product of high quality and rich nutrients in two months or less. There are small-scale models and large-scale models vermicomposting (Pirsahebet *et al.*, 2013) and several studies have been directed on

vermicompost from food waste like sugar beet (Khalfiet *et al.*, 2005), different types of coconut wastes (Tahir and Hamid, 2012), mixing municipal solid waste and sewage sludge (Hemalatha, 2012) and animal manure (Singhet *et al.*, 2012).

Theoretically, vermicompost has high economic worth and act as soil replenishment for plant growth (Jayakumar *et al.*, 2011). The casts have two times magnesium, 15 times nitrogen and seven times potassium compared to the surrounding soil (Kaviraj and Sharma, 2003). Vermicompost promotes better root growth and nutrient absorption (Sultana *et al.*, 2015). It supplies a suitable mineral balance, improves nutrient levels and acts as complex fertilizer particles (Kumar, 2016). Fruits, flowers and vegetables and other plant products grown using vermicompost have better keeping quality (Arancon and Edwards, 2007).

Vermicompost is an ecofriendly natural fertilizer free from chemical inputs and does not have any adverse effect on soil, plant and environment (Alidadiet *et al.*, 2013). It is considered as an excellent product, since it is consistent, it has desirable aesthetics, minor levels of contaminants and hold nutrients over a longer period without impacting the environment (Singh *et al.*, 2008).

## **2. Materials and Methods**

The experiment was carried out at Mangalore University, Department of Biosciences, from March 2016 to December 2016.

### **2.1. Collection of food waste**

The food wastes used as the test sample were collected from men's hostel of Mangalore University and were found to contain cooked rice, pieces of cabbages, carrots, beetroots, tomatoes, beans, potatoes and other vegetable items. The total volume (mass) of the collected food waste was 100kg by which was pre-composted for 20 days prior to pit- and vermi-composting.

### **2.2. Pre-composting**

The pre-composting has been done according to Mupondiet *et al.* (2011) procedures. The pre-composting pit of the size of 1m<sup>3</sup> was filled with food waste collected which turned every 4 days so as to ensure that the pile of waste was well aerated (open pit) and decomposed for a period of 20 days. After the pre-composting period, two different plastic bins of the same size (60 cm×45cm×30 cm) have been used for further experiment to produce vermi- and pit-compost.

### **2.3. Pit-composting**

Following the procedure of Inbaret *et al.*, 1993, the 15kg of pre-composted food waste was taken in the plastic bin and undergone biological process to produce pit-compost. An adequate quantity of water was sprinkled 2 times a week to maintain the moisture; the experimental set up for production of compost was kept for 65 days.

### **2.4. Vermi-composting**

Vermicomposting bin method has been applied according to Adhikary(2012). The 15kg of pre-composted food waste and fresh cow dung (4:1) was taken in in the bin subjected to vermi-composting. The fresh cow-dung was in bottom and top of the bin to provide an initial favorable

environmental condition for the worms. Composting earthworms, *Eudriluseugeniae* of different age groups collected from vermicomposting unit, Mangalore University were used. The 25g of healthy earthworms (*Eudriluseugeniae*) were introduced in vermicomposting bin under controlled ideal conditions by periodically sprinkling of an adequate quantity of water. To avoid disordering in the vermicompost production process, materials considered unacceptable to earthworms were removed before pre-composting period. The experimental set up for vermi-composting was kept for 65 days.

### **2.5. Physical characteristics and Macro-nutrients analysis**

Composts were harvested and samples of both vermi- and pit-composts were collected, air dried, finely powdered and undergone the laboratory tests. The physical and macronutrient parameters have been determined using the standard methods and instrumentations. The pH was determined potentiometrically using pH meter, while the electric conductivity was determined by wet paste method using Ec-meter. The nitrogen (N), phosphorous (P), potassium (K) contents were analysed by the method of Santhiet *al.* (2003). The complexometry titration method was used to determine the content of magnesium and calcium (Mossman *et al.*, 1996), and Sulfur was determined by turbidimetry method using spectrophotometer.

### **2.6. Bioassays for vermi- and pit-compost**

The experiment carried out to compare organic manure (pit-composting and vermicomposting) delivered from food waste using *Pisumsativum L.* plant following the method of Khan and Ishaq (2011). The seven parameters such as plant height, weight/yield, internodes, flowers, pods, leaves and roots have been considered to assess the effectiveness of compost on plant growth and production.

The 15 plastic pots by which 5 reserved for control; 5 for pit-compost; and 5 for vermicompost have been applied as field experiments. There were only garden soils in the control pots whereas in the pots subjected to vermin- and pit-compost pots, the soil was mixed with the composts in the ratio of 3:1 (75% of soil +25% of the compost).

The germination of seeds was done according to the method used by Bukvićet *al.* (2007). Before germination, the seeds were selected and washed with distilled water, sterilized in 1% (v/v) sodium hypochlorite for approximately 2min, then washed again and dried at room temperature (25°C) for approximately 1h. The 8 seeds of plant have been sown in each pot and kept in the same environment and conditions for further observation. The germination rates were determined to compare the influence of vermicompost and pit compost.

### **2.7. Data presentation and analysis**

During the experiment, the data recorded were processed and findings were presented in form of tables for which recommendation and conclusions were based. The data were statistically analyzed using Ms. Excel and SPSS 22.0 for one-way analysis of variance (ANOVA) and nonparametric tests at the 0.05 level. The standard deviation of the mean values was calculated for each treatment and F-test was applied to the data to determine the significant differences. The values were also compared

for significant difference using Scheffe's test and the differences between treatments were considered significant if  $p \leq 0.05$ .

### **3. Results and Discussion**

#### **3.1. Composts production from food waste**

Vermicompost and pit-compost considered as source of plant macro-nutrients. Although, the amount of nutrients provided may vary greatly depending on the starting feedstock, manner of composting, processing time and maturity of the composts. Based on the time taken to run both compost experiments, after 65 days the quantity of both vermi-compost and pit-compost were 11.25kg and 12kg respectively. The results indicated that there was 25% reduction in the volume of the material wastes subjected to vermicomposting and 20% for pit-compost. The question arising here is to know how long it could take for pit-compost to be reduced at 25% (means 3.75kg) as in vermi-compost. The simple mathematics can help us to calculate the time required as follow:

$$\textit{The volume reduced for pitcompost at 65 day} = 15\textit{kg} - 12\textit{kg} = 3\textit{kg}$$

$$\textit{The time taken for reduction of 1kg in pitcompost} = \frac{65}{3} \textit{ days}$$

$$\textit{The time required for reduction of 3.75kg} = \frac{65 \times 3.75}{3} \textit{ days} = 81\textit{days}$$

The finding revealed that pit-compost required an extra of 16 days to be the same quantity as in vermicompost. Therefore, the earthworms "*Eudriluseugeniae*" used had played a big lore in waste degradation as they have adaptability to consume a variety of organic wastes (Chattopadhyay, 2012). However, both pit- and vermi-composting have widely been recognized as one of the most efficient and eco-friendly method for converting food waste into valuable products, the increment in weight reduction shown that vermicomposting can be taken as effective methods than pit-compost for recycling of food waste.

#### **3.2. Physico-chemical Analysis of Vermi- and Pit-compost**

The physical parameters determined were color, odor, pH, Electric conductivity, moisture content and bulk density, while the Chemical (macronutrients) were N, P, K, Ca, Mg, and S.

Table 1: Physico-chemical analyses of Vermi- and Pit-composts

No	Tests parameters	Vermi-compost	Pit-compost
<b>Physical</b>			
1	Color	Leather	Soot
2	Odor	Nil	Nil
3	pH	7.26±0.11	7.2±0.10
4	EC	0.38±0.03	0.41±0.06
5	Moisture content (%)	15±2.27	12.8±1.57
6	Bulk density (g/cm <sup>3</sup> )	0.578±0.03	0.625±0.05
<b>Macronutrients</b>			
7	Nitrogen (N) (%)	2.56±0.22	1.53±0.29
8	Phosphorus (P) (%)	1.42±0.20	0.75±0.09
9	Potassium (K) (%)	1.72±0.10	1.18±0.11
10	Calcium (Ca) (%)	6.68±0.60	4.24±0.28
11	Sulfur (S) (%)	0.47±0.08	0.65±0.22
12	Magnesium (Mg) (%)	2.0±0.30	1.23±0.20

The results revealed that there was an increasing level of physico chemical parameters such as moisture content, pH, macro nutrients (N, P, K, Ca and Mg) in vermicompost when compared to pitcompost. This may be because of more biodegradation process by the action of earthworms degraded food wastes by the action of saprophytic microorganisms present in the gut of earthworms. The electric conductivity and pH values were found to be within the optimal range for plant growth. Both composts are moderately alkaline and the slightly difference may be attributed to the intervention of *Eudriluseugeniae* used in vermicomposting process to digest the waste material. The odor was found to be nil in both composts because composting process transforms the odorous organic waste into an aesthetically product. The bulk density value also was found to be in the range as found by Khater(2015).

It was also found that almost macronutrients analysed were found to be high in vermicomposting than in pit-composting except sulfur. This can be linked to the presence of earthworms in vermi-compost and the time period of composting. Vermicomposting was found to enhance total nitrogen, total phosphorus, total potassium, total calcium, total magnesium while decrease in total sulfur than pitcompost as supported by Bhat *et al.* (2017). It was revealed that N is required for crop production (Nadeem *et al.*, 2014), Phosphorus and Potassium were found to be vital component for plant growth and development (Huang *et al.*,2011; Zlatev and Lidon, 2012). The Ca was found to protect plants from biotic and abiotic stresses (Yang *et al.* 2013). Magnesium contributes to plant photosynthesis and alleviates heavy metal stresses (Chen and Ma, 2013).

### 3.3. Bioassay analysis of *Pisum sativum L*

#### 3.3.1. Influence of composts on germination

The term seed germination refers to the overhang of a root and shoots from the seed coats, the root penetrates in the soil and the shoots appear above the soil surface. It is well documented that compost from organic waste has direct impact to germination (Ravimycin, 2016). The table 2 denotes the data recorded from the experiment carried out on *Pisumsativum L.* plant by employing soil, vermi-compost and pit-compost.

Table 2: Influence of manure on germination rate (%) of *Pisumsativum L.* plant

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F at 5%
Between Groups	104.17	2	52.08	0.29	0.75	4.21
Within Groups	1601.56	9	177.95			
Total	1705.73	11				

Once  $p > 0.05$  and the calculated F- value at 5% is great than F- critical value on the F- table, this support the null hypothesis of non-difference among treatment about germination rate.

### 3.3.2. Comparative analysis of vermi- and pit-compost based on plant growth and yield parameters.

The composts used influenced not only the germination rate but also the plant growth and yield. The growth of plants can be measured in terms of plant height, number of leaves, internodes, root length, and number of flower. On the other hand, the yield was determined in terms of number of pods and production in grams. The table 3 represents the data recorded from the experiment carried out on *Phaseolus vulgaris L.* and *Pisumsativum L.* plants by employing garden soil, vermi-compost and pit-compost.

Table 3: Results recorded during the experiments

Properties	Control	Pit-compost	Vermicompost
Color	Spring green	Emerald	Pigment green
Plant height (cm)	31.36±2.64	39.84±2.26	48.2±3.73
Number of leaves	20.64±2.74	28.94±2.08	35.64±2.66
Internodes	10.4±1.14	14±0.71	17.4±1.14
Roots formation in Cm	14.72±1.70	20.46±2.60	25.4±1.67
Number of flowers	4.18±0.76	5.58±0.70	8.18±0.79
Number of pods	4.04±0.65	5±1	7.84±0.92
Yields (gr)	3.47±0.45	4.13±0.63	6.44±1.09

The results in table 3 are expressed as mean and standard error mean for garden soil, garden soil + vermi-compost, and garden soil + pit-compost. We have tested if there is a difference in means of

parameters at 5% significance level. The null hypothesis ( $H_0$ ) was “there is no significance difference in the three treatments” and the testing hypothesis ( $H_1$ ) was “there is significance difference in the three treatments”.

Table 4: Analysis of variance of *Pisumsativum L.* for all parameters

Parameters	Source of variation	SS	d.f	MS	Computed Value	Critical values F (5%)
Plant height in Cm	Between sample	708.976	2	354.488	40.86	$F_{(2,12)} = 3.88$
	Within sample	104.104	12	8.675		
	Total	813.08	14			
Number of leaves	Between sample	564.6335	2	282.3168	44.862	$F_{(2,12)} = 3.88$
	Within sample	75.516	12	6.293		
	Total	640.1495	14			
Internodes	Between sample	122.5335	2	61.2668	59.3	$F_{(2,12)} = 3.88$
	Within sample	12.4	12	1.0333		
	Total	134.9335	14			
Roots formation	Between sample	285.6895	2	142.8448	34.42	$F_{(2,12)} = 3.88$
	Within sample	49.8	12	4.15		
	Total	335.4895	14			
Number of flowers	Between sample	41.2	2	20.6	36.6548	$F_{(2,12)} = 3.88$
	Within sample	6.744	12	0.562		
	Total	47.944	14			
Number of pods	Between sample	38.9976	2	19.4988	25.7	$F_{(2,12)} = 3.88$
	Within sample	9.104	12	0.7587		
	Total	48.1016	14			
Yields in grams	Between sample	24.2595	2	12.1298	18.9558	$F_{(2,12)} = 3.88$
	Within sample	7.6789	12	0.6399		
	Total	31.9384	14			

The table 4 shown that the computed value of F (F-ratio) at 5% in all parameters is greater than the critical values of  $F_{(2,12)}$ , which is equal to 3.88. This analysis supports the test-hypothesis of significant difference between treatments (control, pit-compost and vermicompost).

The Scheffe’s test was applied to find out which pairs of treatments differ significantly by determining the critical difference for each pair of treatments (Kothari and Gaurav, 2014) and the results are shown in the table 5.

Table 5: Critical difference among pairs of treatments at 5%

Parameters	Pair of Treatment	Difference of Sample Means	Critical Difference at 5%
Plant height in Cm	Control and Pit-compost	8.48	5.189*
	Pit-compost and Vermi-compost	8.36	5.189*
	Vermi-compost and Control	16.84	5.189*
Number of leaves	Control and Pit-compost	8.3	4.4197*
	Pit-compost and Vermi-compost	6.7	4.4197*
	Vermi-compost and Control	15	4.4197*

Internodes	Control and Pit-compost	3.6	1.7909*
	Pit-compost and Vermi-compost	3.4	1.7909*
	Vermi-compost and Control	7	1.7909*
Roots formation	Control and Pit-compost	5.74	3.5891*
	Pit-compost and Vermi-compost	4.94	3.5891*
	Vermi-compost and Control	10.68	3.5891*
Number of flowers	Control and Pit-compost	1.4	1.3208*
	Pit-compost and Vermi-compost	2.6	1.3208*
	Vermi-compost and Control	4	1.3208*
Number of pods	Control and Pit-compost	0.96	1.5346 <sup>ns</sup>
	Pit-compost and Vermi-compost	2.84	1.5346*
	Vermi-compost and Control	3.8	1.5346*
Yields in grams	Control and Pit-compost	0.652	1.4093 <sup>ns</sup>
	Pit-compost and Vermi-compost	2.312	1.4093*
	Vermi-compost and Control	2.964	1.4093*

\*Differ significantly

<sup>ns</sup> Not differ significantly

Hence, all difference between corresponding sample means are higher than the critical difference except for number of pods and yields where the difference of sample means are lesser than their corresponding critical difference; therefore control, pit-compost, and vermi-compost have different effect on 7 parameters but control and pit compost did not show the significant difference in pods and yield of *Pisumsativum L.* plant.

Bioassay results indicated that vermi-compost was found to be highly effective in terms of plant growth and yield compared to pit compost and garden soil. The predominance of macronutrients like nitrates, phosphates and exchangeable calcium and soluble potassium in vermicompost stimulated the plant growth, yield and quality (Morgan and Connolly, 2013). Vermicompost releases nutrients relatively slowly in the soil and improves quality of the plants along with physical and biological properties of soil. Vermi- and pit-compost provide all nutrients in readily available forms and also enhances uptake of nutrients by plants and plays a major role in improving growth and yield of different field crops (Sreenivaset *al.*, 2000). Unlike other composts, vermicompost has large particulate surface areas to retain plant nutrients and contains worm mucus which helps prevent nutrients from washing away, holds moisture better and thus helps in increased plant growth (Singh *et al.*, 2004).

#### 4. Conclusion

Vermi-compositing appears to be the most promising as high value bio-fertilizer which not only raising the agriculture productivity but also is cost effective strategy of waste management and pollution free. Use of vermicompost improves the air- water relationship of soil, water retention capacity and encourages root development of the plants. The integrated effect of all the nutrients presented in vermi-compost results in increased growth and yield of *Pisumsativum L.* plant compared to pit-compost and garden soil (control).



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