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# RECYCLING OF SOLID WASTES INTO ORGANIC FERTILIZERS USING VERMICOMPOSTING

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## ABSTRACT

*Increasing human population, urbanization and change in life style has increased the wasteload and there by increasingpollution loads on the urban environment to an unmanageable and alarming proportions. The existing waste dumping sites are full beyond capacity and under unsanitary conditions leading to pollution of water sources and spreading communicable diseases, foul smell, release of toxic metabolites, unaesthetic ambiance and eye sore etc. Vermicomposting is the better option to tackle with this problem.This project focuses on recycling process of vegetable waste fruit waste by adopting Vermitechnology. The produced compost is rich in essential micro and macronutrient along with microorganisms in very simple form. In this study Cow Dung was used as conditioners the optimal conditioner requirement was found by conducting lab study using different mixing ratios of Vegetable waste(VW),Fruit waste(FW) and Cow Dung (CD). The changes in nutrient content were monitored. The Eudriluseugeniaeworm was chosen for the study.*

*Key words :Vermitechnology, Vegetable waste, Fruit waste, Eudriluseugeniae*

## 1. INTRODUCTION

Solid waste is defined as the organic and inorganic waste materials produced by different sources and have lost value in the eye of their owner.Every year, human, livestock and crops produce approximately 38 billion metric tons of organic wastes worldwide. The safe disposal and environmentally friendly management of these wastes have become a global priority. In India, the amount of waste generated per capita is estimated to increase at a rate of 1–1.33% tones annually(WHO 2014) . In such conditions, the total waste generated in 2047 would be approximately above 260 million tons(WHO 2014), more than five times the present level. This enormous increase in solid waste will have significant impacts in terms of the land required for disposing this waste as well as on methane emissions etc., Moreover, 40–60% solid wastes in India are of organic nature and open dumping of such garbage creates the issue of environmental pollution(CPCB 2015). Suggest that organic waste can be converted into some useful products for agriculture and industries, if processed through cost effective technique. Organic waste recycling is an efficient and environmental friendly technology to convert wastes into the value-added products. Composting is the most economical and sustainable option for onsite organic waste management as it is easy to operate and can be conducted in contained space, Onesuch onsite method of solid waste management is vermicomposting. Vermicomposting technology is globally becoming a popular solid waste management technique. Vermicomposting is the bioconversion of organic waste into a bio-fertilizer due to earthworms' activity. The earthworms feed on the organic waste and the earthworms' gut acts as a bioreactor whereby the vermicasts are produced. By the time the organic waste is excreted by the earthworms as vermicasts, it will be rich in nitrogen (N), phosphorous (P) and potassium (K) as well as trace elements depending on the feedstock type used. The vermicomposting process is a mesophillic process and operating conditions such as temperatures, pH, electrical conductivity and moisture content levels must be optimized. Normally, the vermicomposting process takes place in vermi-reactors which include plastic, earthed pots and wood worm bins.This project focuses on recycling process of solid waste by adopting Vermitechnology. The end product of vermicompost is rich in essential micro and macronutrient along with microorganisms in very simple form. In this study Vegetable waste, Fruit waste and Cow Dung was used as conditioners the optimal conditioner requirement was found by conducting lab study using different mixing ratios of Vegetable waste(VW), Fruit waste (FW) and Cow Dung (CD). The changes in nutrient content were monitored. The *Eudriluseugeniae* was chosen for the study. The species for use in vermicomposting largely depends on temeperature. In tropical regions, *E.eugeniae*, the African night crawler, is commonly used as a composting worm and as a source of protein meal (Ashok Kumar, 1994; Kale, 1998).

## 2. MATERIALS AND METHOD

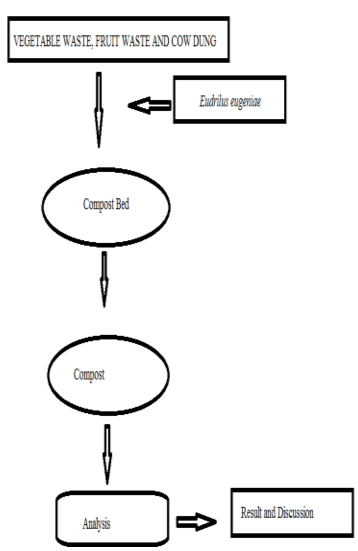



Fig 2.1 Methodology

In this project plastic bin method has chosen, because plastic tends to keep the compost moist, less messy and easier to maintain.Six plastic bins were chosen for the various composition of waste, 1cm diameter of holes were made for aeration, in the bottom of the bin 0.5cm diameter of holes were made for the removal of excess water content and to remove the urinals which are made by the earth worm.The collected waste was dumped in a composting bin for 15 days; this was carried out to avoid exposure of earthworms to the initial temperature increase during the thermiphillic phase of composting of organic content of waste. The healthy earthworm (Clitellate stage), *Eudriluseugeniae* was collected from PeriyarManiammai institute of science and techonology.

**Fruit waste and Vegetable waste**

These wastes contain 8–18% total solids (TS), with a total volatile solids (VS) content of 86–92%. The organic fraction includes about 75% easy biodegradable matter (sugars and hemicellulose), 9% cellulose and 5% lignin. Anaerobic digestion of FVW was studied under different operating conditions using different types of bioreactors. It permits the conversion of 70–95% of organic matter to methane, with a volumetric organic loading rate (OLR) o f 1–6.8 g versatile solids (VS)/l day. These waste were collected from Tiruchirapallimarket .

Fig 2.2 showing Fruit waste and vegetable waste

**COW DUNG**

Traditionally cow dung has been used as a fertilizer, though today dung is collected and used to produce biogas. This gas is rich in methane and is used in rural areas of India/Pakistan and elsewhere to provide a renewable and stable source of electricity.

The cow dung was collected from Tiruchirapalli district.

Fig 2.3 *Eudriluseugeniae*

Fig 2.4Experimental setup

## 3. EXPERIMENTAL PROCEDURE

The compost bins was filled with different composition of Vegetable waste (VW), Fruit waste (FW) and Cow dung (CD). The quantity of each bin was 5Kg. All containers were kept in dark at room temperature. The moisture content was maintained at 60 – 80% throughout the study period by sprinkling adequate quantities of water. These mixtures were turned over manually every day for 15 days in order to eliminate volatile toxic substances. After 15 days, 100 g of Clitellate stages of earthworms *Eudriluseugeniae*was introduce in each container.The compost was analyzed for nutrient content at 15 days interval. The sample was oven dried, sieved to get equal size and analyzed for various parameters. The Total Solids, pH, Moisture Content, Potassium and Phosphorous were analyzed as per the standard methods.

| Feed Mixture No. | Vegetable waste (VW) (kg) | Fruit waste (FW) (kg) | Cow dung (CD) (kg) | Rice husk (RH) (kg) |
|---|---|---|---|---|
| Case 1 | 1.5 | - | - | - |
| Case 2 | - | 1.5 | - | - |
| Case 3 | - | - | 1.5 | - |
| Case 4 | 1.5 | - | 1.5 | - |
| Case 5 | 1.5 | 1.5 | 1.5 | - |
| Case 6 | 1.5 | 1.5 | 1.5 | 1.5 |

**Characteristics of feed mixture**

The initial characteristics of VW, FW and CD were analyzed for pH, Total Solids (TS),Total Organic Carbon (TOC), Total Kjeldahl Nitrogen (TKN), Total Phosphorous (TP), Total Potassium (TK) and C/N ratio as per the standard methods. The characteristics of raw materials are reported in Table

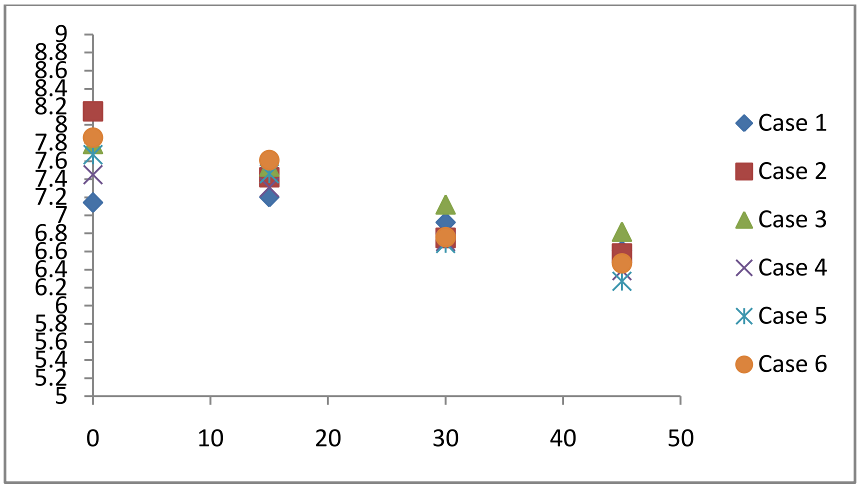
| PARAMETERS | CASE 1 | CASE 2 | CASE 3 | CASE 4 | CASE 5 | CASE 6 |
|---|---|---|---|---|---|---|
| PH | 7.41 | 8.15 | 7.79 | 7.45 | 7.67 | 7.86 |
| TS (%) | 41.90 | 41.17 | 38.41 | 40.20 | 40.50 | 41.71 |
| TOC (%) | 18.21 | 17.60 | 21.20 | 17.60 | 18.70 | 20.50 |
| N (%) | 0.45 | 0.61 | 0.63 | 0.50 | 0.58 | 0.65 |
| P (%) | 0.28 | 0.42 | 0.42 | 0.63 | 0.21 | 0.59 |
| K (%) | 0.30 | 0.23 | 0.41 | 0.55 | 0.15 | 0.51 |

# 4. RESULT AND DISCUSSION

Analysis of vermicompost

Comparison in variation of pH

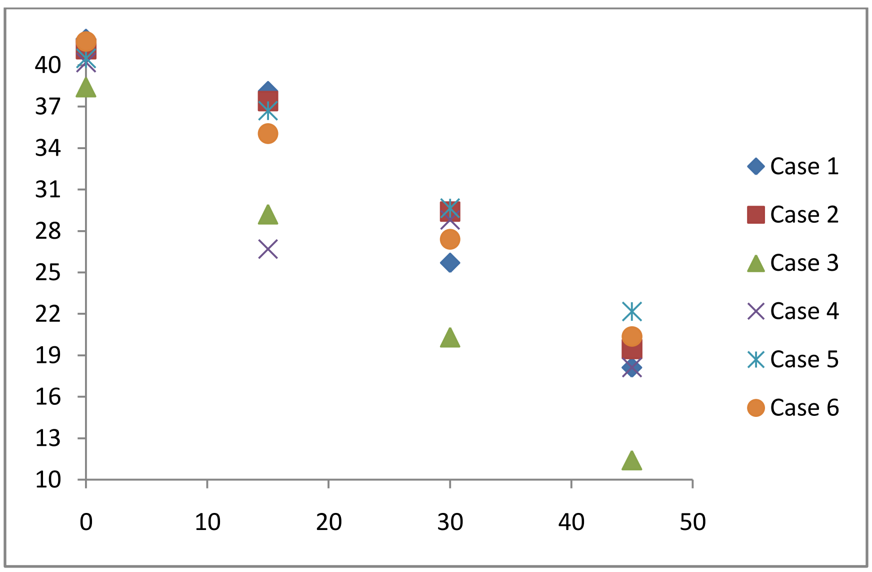
| Bin | $0^{th}$ day | $15^{th}$ day | $30^{th}$ day | $45^{th}$ day |
|---|---|---|---|---|
| Case 1 | 7.14 | 7.20 | 6.92 | 6.61 |
| Case 2 | 8.15 | 7.42 | 6.75 | 6.58 |
| Case 3 | 7.79 | 7.54 | 7.12 | 6.82 |
| Case 4 | 7.45 | 7.31 | 6.71 | 6.39 |
| Case 5 | 7.67 | 7.46 | 6.69 | 6.27 |
| Case 6 | 7.86 | 7.61 | 6.76 | 6.47 |




All the mixtures show that there was a decrease in pH from alkaline to acidic condition as shown, in case 1 the pH value decreases from 7.14 to 6.61, in case 2 the pH value decreases from 8.15 to 6.58, in case 3 the pH value decreases from 7.79 to 6.82, in case 4 the pH value decreases from 7.45 to 6.39, in case 5 the pH value decreases from 7.67 to 6.27, in case 6 the pH value decreases from 7.86 to 6.47 and in all cases it is within the limit.

Comparison in variation of Total Solids

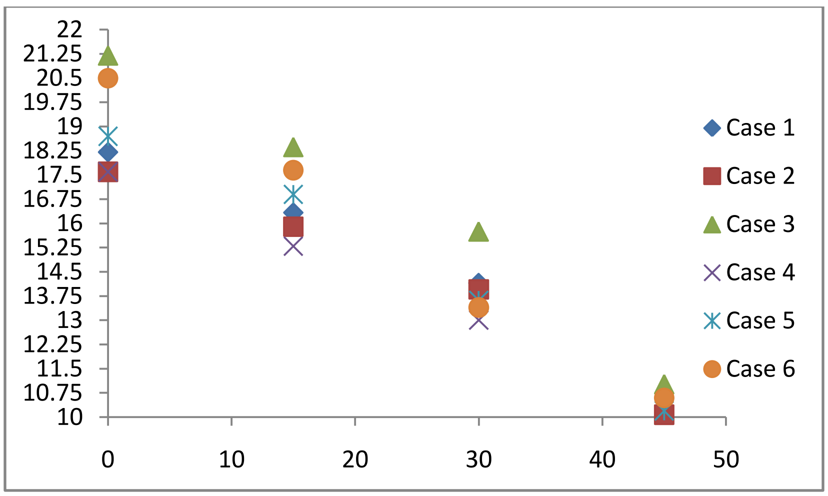
| Bin | 0th day | 15th day | 30th day | 45th day |
|---|---|---|---|---|
| Case 1 | 41.9 | 38.12 | 25.7 | 18.12 |
| Case 2 | 41.17 | 37.4 | 29.4 | 19.47 |
| Case 3 | 38.41 | 29.21 | 20.31 | 11.42 |
| Case 4 | 40.20 | 26.70 | 28.8 | 18.13 |
| Case 5 | 40.5 | 36.71 | 29.65 | 22.17 |
| Case 6 | 41.71 | 35.05 | 27.4 | 20.36 |




The appreciable results for the degradation of total solids is obtained are listed. From the above analysis it is proved that the usage of *Eudriluseugeniae* gives more reduction of solids waste. In case1 the TS value decreases from 41.9% to 18.12%, In case2 the TS value decreases from 41.17% to 19.47%, In case3 the TS value decreases from 38.41% to 11.42%, In case 4 the TS value decreases from 40.20% to 18.13%, In case 5 the TS value decreases from 40.5% to 22.17%, In case 6 the TS value decreases from 41.17% to 20.36%.

Comparison in variation of Total Organic Carbon

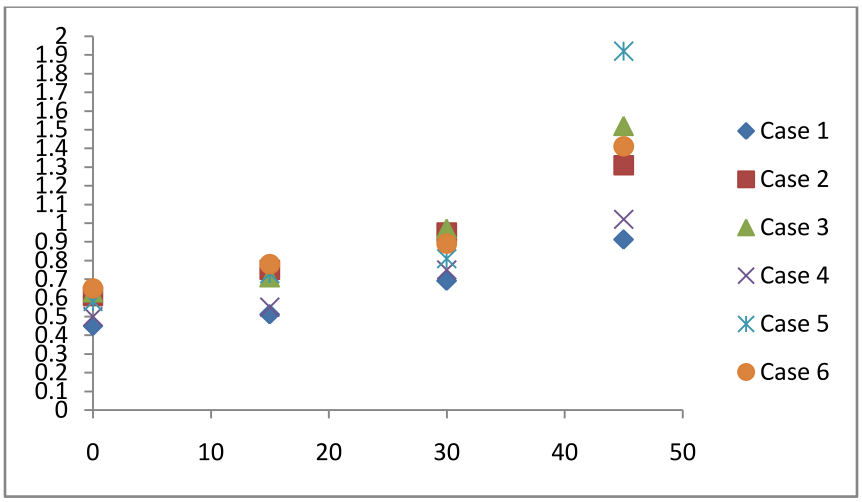
| Bin | $0^{th}$ day | $15^{th}$ day | $30^{th}$ day | $45^{th}$ day |
|---|---|---|---|---|
| Case 1 | 18.21 | 16.34 | 14.16 | 9.7 |
| Case 2 | 17.6 | 15.9 | 13.96 | 10.08 |
| Case 3 | 21.2 | 18.37 | 15.75 | 11.03 |
| Case 4 | 17.6 | 15.3 | 13.01 | 8.4 |
| Case 5 | 18.7 | 16.9 | 13.62 | 10.2 |
| Case 6 | 20.5 | 17.65 | 13.4 | 10.6 |




TOC was lost as carbon di oxide ($Co_2$) by the end of Vermicomposting period From Table it is shown that *Eudriluseugeniae* reduce more TOC. Losses of carbon might responsible for nitrogen addition. In case 1 TOC value decreases from 18.21 % to 9.7%, In case 2 TOC value decreases from 17.6% to 10.08 %, In case 3 TOC value decreases from 21.2% to 11.03%, In case4 TOC value decreases from 17.6% to 8.4%, In case 5 TOC value decreases from 18.7% to 10.2%, In case 6 TOC value decreases from 20.5% to 10.6%.

Comparison in variation of Nitrogen

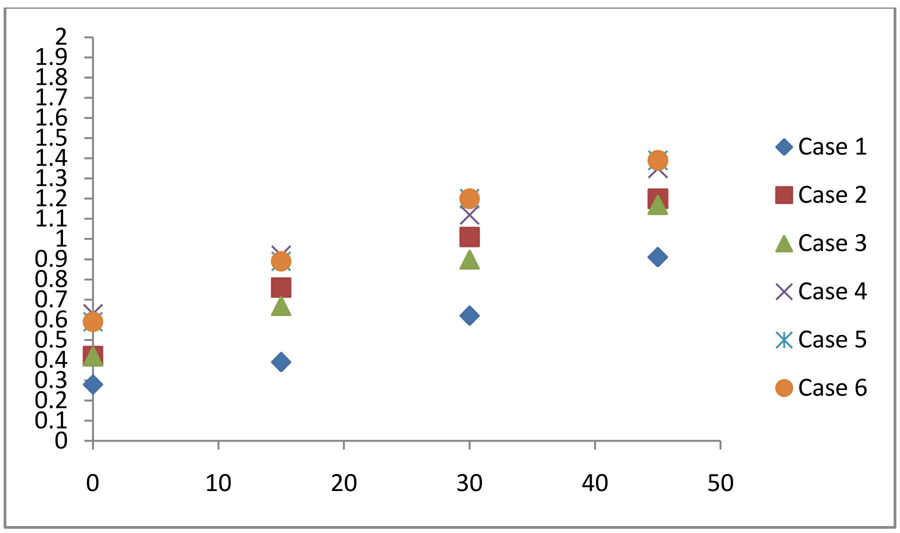
| Bin | $0^{th}$ day | $15^{th}$ day | $30^{th}$ day | $45^{th}$ day |
|---|---|---|---|---|
| Case 1 | 0.45 | 0.512 | 0.691 | 0.912 |
| Case 2 | 0.61 | 0.75 | 0.95 | 1.31 |
| Case 3 | 0.63 | 0.71 | 0.97 | 1.52 |
| Case 4 | 0.5 | 0.55 | 0.75 | 1.02 |
| Case 5 | 0.58 | 0.73 | 0.81 | 1.92 |
| Case 6 | 0.65 | 0.78 | 0.89 | 1.41 |




From the table case 5 shows a high increase in N, from 0.58 to 1.92.It is proven that increase in TN content is more effective in the usage of *Eudriluseugeniae*. The final TN content in Vermicompost is dependent on the initial nitrogen present in the feed material and the degree of decomposition. Addition of nitrogen in the form of mucus, nitrogenous excretory substances, growth stimulating hormones and enzymes from earthworms.

Comparison in variation of Phosphorous

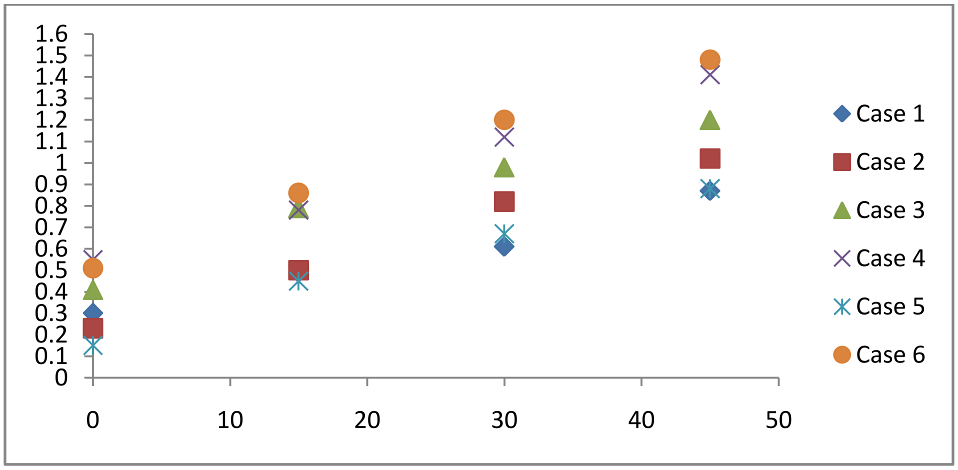
| Bin | $0^{th}$ day | $15^{th}$ day | $30^{th}$ day | $45^{th}$ day |
|---|---|---|---|---|
| Case 1 | 0.28 | 0.39 | 0.62 | 0.91 |
| Case 2 | 0.42 | 0.76 | 1.01 | 1.2 |
| Case 3 | 0.42 | 0.67 | 0.9 | 1.17 |
| Case 4 | 0.63 | 0.92 | 1.12 | 1.35 |
| Case 5 | 0.21 | 0.43 | 0.64 | 0.82 |
| Case 6 | 0.59 | 0.89 | 1.2 | 1.39 |




From Table Phosphorous content was higher in the final compost than the initial feed mixtures. Increase in TP during Vermicomposting is probably due to mineralization and mobilization of phosphorous due to bacterial and faecal phosphates activity of earthworms

Comparison in variation of Potassium

| Bin | 0th day | 15th day | 30th day | 45th day |
|---|---|---|---|---|
| Case 1 | 0.30 | 0.49 | 0.61 | 0.87 |
| Case 2 | 0.23 | 0.5 | 0.82 | 1.02 |
| Case 3 | 0.41 | 0.79 | 0.98 | 1.2 |
| Case 4 | 0.55 | 0.78 | 1.12 | 1.41 |
| Case 5 | 0.15 | 0.45 | 0.67 | 0.88 |
| Case 6 | 0.51 | 0.86 | 1.2 | 1.48 |




TK content were also higher in the final product than in the initial feed mixtures it increases from 0.51% to 1.48% . TK content is more effective in the usage of *Eudriluseugeniae*. They have attributed this decrease to leaching of soluble elements by excess water that drained through mass. Benitez et al., (1999) have found the leachates collected during Vermicomposting process had higher potassium concentrations. This study support out results, as water was sprinkled in such quantities in this study that there was no excess water, which avoided the leaching of minerals with runoff water.

## 5. CONCLUSION

The observations indicated the *Eudriluseugeniae*, in terms of loss of TOC,and rich in nutrients. These characteristics make these Vermicompost useful as soil conditioner and healthy organic fertilizers. The feed mixture case 6(VW+FW+CD=RH) suitable mixture of Vermicomposting process. The mixture which is having N value 1.92 K 1.48 and P 1.39 is rich in nutrient content and is justified that this fed mixture produces high nutrient compost than the other feed mixtures. The use of vegetable waste and fruit waste as raw material in the Vermicomposting systems can potentially help to convert these waste into value- added product, it will avoid its disposal in open dumps, ocean disposal etc.,

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