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Status of NPK in vermicompost prepared from diverse categories of organic waste material

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ABSTRACT

Vermicomposting is the process of conversion of degradable waste material to a useful compost. Diverse categories of organic waste were collected and categorized into Kitchen, Garden and agricultural (paddy) waste on the basis of their source and origin. The waste material was decomposed using earthworms *Eisenia fetida*. Temperature and moisture was regulated and after approximately 2 months the dark brownish black colored compost was ready. The total weight of vermicompost harvested at the end of the study was 3 kg approximately. The present study focuses on to the preparation of vermicompost using different wastes using earthworms *Eisenia fetida* and analyze and compared the level of macronutrients like nitrogen, phosphorus, and potassium. Four sets of experimental tanks were used in this study. Each representing different waste material to be used as a raw material for composting. Each experimental tank contains half kilogram juvenile earthworms. In first set (A) of experiment the bedding was prepared by partially decomposed cow dung and soil. In second set (B) of experiment the bedding was of partially decomposed cow dung, soil with partially decomposed kitchen waste. The third set (C) of this bedding was of partially decomposed cow dung, soil with partially decomposed garden waste. In the fourth set (D) the bedding was of partially decomposed cow dung, soil and partially decomposed agriculture (Paddy) waste. All sets were mixed in 5:1:1 (wt/wt/wt) ratio. The pH of cow dung compost (control, A) was 8.0. pH of each compost are in range of 7.5 – 8.1. The percentage of Nitrogen (N) was found to be low in set A (Cow dung + soil) and Set D (agricultural/ paddy waste) while Nitrogen content was found to be high in Kitchen and Garden waste experimental set B and C respectively. There was no significant difference in the Phosphorus (P) content in compost A and D. While compost B and C have high phosphorus %. All compost showed significantly higher K contents than the cow dung compost (A), however the potassium (K) contents was found to be highest in compost A. When the NPK composition of all compost was compared NPK value is highest in vermicompost prepared from kitchen waste (Set B) and garden waste (Set C).

Key words : *Eiseniafetida, Garden waste, Kitchenwaste, Nitrogen, Paddy waste, Phosphorus, Potassium, Vermicompost*

Introduction

The world is facing problem of enormous generation of solid waste and lack of management of this solid waste. The major portion of waste comes from garden waste, agriculture waste and kitchen waste. Vermicomposting could be the best option to manage the continuous generation of solid waste. Vermicomposting is the process of conversion of biodegradable material into a soil nourshing compost through the agency of earthworms a member of detritivorous cycle belonging to phylum annelida. Vermicomposting process greatly reduces the waste and convert it into a soil macronutrients releasing

compost. Vermicompost produced in the high-quality of the compost which is better than commercial compost available in the market. Vermicomposting process is faster than other composting because the waste material passes through the earthworm gut.

The biology and ecology of *Eiseniafetida* and *Eisenia andrei*, when fed on animal manures or sewage sludge has been investigated by many researchers (Graff, 1953), (Graff, and Satchell, 1967); Watanabe and Tsukamoto, (1976). This process helps the conversion of household waste into compost within 30 days and the ratio Carbon to nitrogen is greatly reduced while retaining more nitrogen. This method is far better than the traditional method of compost preparation (Parkin and Berry, 1994); Gandhi *et al.* (1997); Adhikary, (2012). In India the epigeic species that are found is *Eudriluseuginae*, *Eiseniafetida* (Neuhauser *et al.,* 1980) Gajalakshmi *et al.* (2001) these species are widely used for vermicomposting.

E. fetida worms are used for vermicomposting of both domestic and industrial organic waste (Albanell, 1988). *E. fetida* is known under various common names such as red worm, brandling worm, pan-fish worm, trout worm, tiger worm, red wiggler worm, and red Californiaearth worm (Orozeo *et al.*, 1996).

Vermicomposting which involves the composting of organic waste through earthworm activity has been observed by Edwards and Webster, 2000 while studying Vermicomposting of sewage sludge. Horticultural residues from processed potatoes, dead plants and the mushroom industry (Edwards, 1988). Vermicomposting of Bio-solids and Beneficial Reuse has been studied by Quintern and Morley (2017). The vermicomposting of organic waste accelerates organic matter stabilization.The vermicomposting process ensure more favorable mineralization (Ramalingam and Ranganathan, (2001). The earthworms can convert 5 kg of kitchen waste into a compost in 60 days. The vermicompost produced in this process is the product of waste biomass which passes through the gut of earthworm the product which is formed is used as a fertilizer (Sherman, 2003). The process involved process of digestion and due to this the material is converted into the worm casting. The product is result of the combined activity of microorganisms and digestive enzymes of earthworm (Atiyeh, 2000; Aira, 2002).

Materials and Method

Collection and processing of waste material

To prepare compost, plastic tank were used. The size of the tank could depend upon the availability of kitchen waste materials. The kitchen waste material was collected and dried in the air and sun for 3-4 days prior to decomposition. After the waste got sufficiently dried up it was cut into small piecesusing the scissor to facilitate the process of decomposition. The cow dung slurry was prepared and was evenly sprinkle on kitchen waste.

Preparation of Bed

Layerof 2-3 inch of farm soil was spread at the bottom of the tub than partially decomposed cow dung was added over the top of the layer of soil along with dried leaves and all other waste that was collected from field and kitchen. The layers are evenly spread and kitchen waste material and decomposed material were continuously added along with cow dung slurry into the tub up to 0.5 to 1.0 feet. The earthworms nearly half kilogram were gently introduce into each experimental tub and the tub was latter covered up so as to prevent the entry of natural predators of earthworm like Lizard, skink, snakes and birds. Care was also taken to protect the complete experimental set up from rain, over-heating. Temperature and moisture was also regulated. The study was carried out from March 2021 to June 2021. The procedure for bed preparation was kept same for all experimental set up only the decomposing substrate was changed in set, B,C and D while set A

Table 1. Table showing composition of each experimental sets

Ratio	Set A (control)	Set B	Set C	Set D
5	Partially decomposed cowdung	Partially decomposed cowdung	Partially decomposed cowdung	Partially decomposed cowdung
1	Soil	Soil	Soil	Soil
1		Kitchen Waste	Garden Waste	Agriculture waste (Paddy)

was kept as control where no decomposing substrate was added only soil was mixed along with cow dung and Earthworm.

The moisture content was 50% throughout the study period and maintained by sprinkling adequate quantity of water. In the interval of seven days the compost mixture of bed was turned up and down manually. After 60 days of set up, granular blackish, brownish vermicompost started appearing on the upper surface of compost beds. After 90 days, compost was strained and worms were removed from the composts. Compost were shed dried and analysed for pH (1:2.5 soil water suspension), nitrogen phosphorus and potassium.

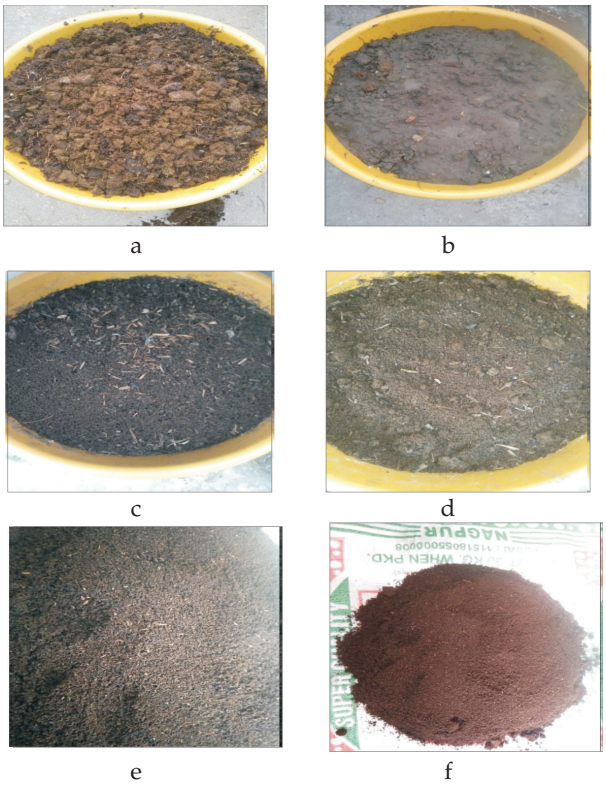

Fig. 1. From a-f: Various stages during the composting of waste material and change in the texture of the composition

Results

The nutrient values of vermicompost obtained in this study are presented in Table 2. The pH of cow dung compost (control, A) value was 8.0. pH of each compost are in the range of 7.5 – 8.1. Nitrogen (N) content (%) is low in cow dung (A) and agricultural paddy waste compost (D) while Nitrogen content is high in Kitchen and Garden waste (B and C). There was no significant difference in the Phosphorus (P) content between the compost A and D while compost B and C have high phosphorus %. All compost had significantly higher Potassium (K) contents than the cow dung compost (A). Potassium (K) contents are high in all vermicompost and highest in compost A.When the NPK composition of all compost is compared NPK value is highest in vermicompost prepared from kitchen waste (Set B) and garden waste (Set C).

Discussion

Waste management is a problematic issue throughout the world. People remain reluctant to manage the waste and throw the waste anywhere.

The kitchen, garden and agriculture waste are high in organic and moisture content. But these wastes are not only difficult for collection, transport and storage but also causes serious environmental pollution. Agriculture paddy waste is burned and is one of the major causes of air pollution in North India.

Vermicomposting is one of the way by means of which biodegradable waste can be managed (Nagavallemma *et al.*, 2004). Simple solution related to vermicomposting, includes vermicomposting at the site of waste production (in homes, restaurants and at marketplaces) (Kostecka *et al.*, 2018).

In small system if these wastes are collected and

Table 2. Values of different parameter in vermicompost (values are given in percentage)

Vermicompost	Initial pH	pH	N% (Nitrogen)	P% (Phosphorus)	K%(Potassium)
Cowdung + Soil (Set A)/Control	6.0	8.0	0.98	1.40	0.8
Kitchen waste+ Cowdung +Soil (Set B)	4.0	8.1	1.7	2.34	17.8
Garden waste +Cowdung+ Soil(Set C)	4.8	7.9	1.8	2.00	15.0
Agriculture paddy waste+Cowdung + Soil(Set D)	5.8	7.5	1.0	1.40	09.6

compost is prepared then to considerable reduction in the volume of waste 85% as well as moisture content is reduced. According to Wu and Smith (1999) the heat generated during the degrading process also helps in reducing the moisture content.

Initial pH of the waste material was 4 to 6. During the vermicomposting process the pH increases. The usual pH values of soil ranges 7.5 to 8. The pH of four composts showed significantly in same range (A - 8.0, B – 8.1, C – 7.9, D - 7.5). Decomposition of nitrogenous substrate in to ammonia that may be attributed overall increase in pH Atiyeh *et al.* (2000).

Similar results have been noted by Mckinley and Vestal 1985. After the composting, a pH increase was observed for substrates C3 (leaves) and C1 (fruit waste). The pH increase is the result of volatilization and microbial decomposition of organic acids, and the release of ammonia by microbial mineralization of organic nitrogen sources (Mckinley and Vestal 1985).

The observed increase in the nitrogen (N) in all composts showed that the activity of earthworm. The increased nitrogen may be due to nitrogenous metabolic products of earthworms (Atiyeh *et al.* 2000) reported that by enhancing nitrogen mineralization, earthworms have a great impact on nitrogen transformation in manure, so that nitrogen retained in the nitrate form. Hand *et al.* (1988) have been already reported that *Eisenia foetida* in cow dung slurry increased the nitrate-nitrogen content. Lee (1992) reported that vermicompost contain more nitrogen, phosphorous and calcium. Phosphate (P) values are higher in all vermicompost. According to Lee (1992) the passage of organic residue through the gut of earthworm releases phosphorus.

Ravichandran *et al.,* 2001 observed more NPK in the vermicompost than that in the initial soil. Available forms of Phosphate is performed partly by earthworm gut wall microbial phosphatase and further released of phosphorus might be attributes to phosphorus solubilizing microorganism present in worm cast (Zhang *et al.,* 2000).

Total potassium (K) concentration was increased in vermicomposts of all the combination except cow dung. Delgado *et al*. (1995) have reported a higher content of K in the new sewage sludge vermicompost.

Kaviraj and Sharma (2003) observed that level of K was increased 10% by *Eisenia foetida* and 5% by *L. maturitii* during vermicomposting.

Sharmila *et al.*, 2019 observed similar NPK range from kitchen waste vermicompost prepared using *E. fetida*.

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