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Eisena fetida (Epigeic Earthworm) Used as a Sustainable Alternative for Preparation of Vermicompost from Vegetable Waste and Cow Dung

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ABSTRACT
Vermicomposting is a biotechnological procedure in which earthworms are utilized to change over the natural squanders into humus like material known as vermicompost. The present research was aimed to transform vegetable waste into nutrient rich vermicompost implying cow dung and incorporation of earthworms. Eisena fetida was incorporated with vegetable waste followed by mixing with cow dung, for time duration of 55 days. During the process of feeding, earthworms encourage the metabolic activity and accelerate the breakdown of organic matter and also stabilize the soil aggregates. The end product was obtained by the process of harvesting which showed the characteristics of color and texture. Vermicomposting is done in order to decrease the need for chemical fertilizers and improve the microbial activity in soil.
Keywords: *Vermicomposting, Esenia fetida, nutrient quality, eco-technology, organic matter.*

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INTRODUCTION

Vermicomposting is a mesophilic process carried out by earthworms, involves ingestion, digestion, and absorption of the organic waste followed by excretion of castings through the worm's metabolic system, which enhance the levels of plant-nutrients of organic waste during their biological activities [16]. Vermicomposting utilizes microorganisms and earthworms that are active at 10˚C to 32˚C (not ambient temperature but temperature within the pile of moist organic material). The process is faster than composting; because the material passes through the earthworm gut, a significant but not fully understood transformation takes place, whereby the resulting earthworm castings (worm manure) are rich in microbial activity and plant growth regulators, and fortified with pest repellence attributes as well. In short, earthworms through a type of biological alchemy are capable of transforming garbage into "gold" [22].

In India, so far, 509 species, referable to 67 genera and 10 families, have been reported [9]. Several earthworm species are bio-accumulators and bio-transformers of toxic chemicals. After the Seveso Chemical Disaster in Italy (1976) when a vast area was contaminated with dioxin", only the earthworms *Eisinea fetida* survived. This indicated the tolerance level of earthworms in worst case scenarios [10].

Earthworms are extremely important in soil formation, principally through their activities in consuming organic matter, fragmenting and mixing it intimately with mineral particles to form aggregates. During their feeding, earthworms promote microbial activity greatly, which inturn accelerates the breakdown of organic matter and stabilization of soil aggregates [15].

Most studies of vermicomposting focus on the species *Eisenia fetida* [17, 21]. It occurs worldwide and naturally colonises in many SOWs, *e.g.* garden waste and animal slurry [6]. *E. fetida* has a rapid growth rate, good temperature tolerance (up to 35°C) and accepts a large range of moisture 60-90% [17]. Moreover, *E. fetida* can be handled easily and it is tolerant to other species [1, 6, 11]. Under optimal conditions, the life cycle of *E. fetida* ranges from 45 to 51 days [3].

Ruz-Jerez *et.al* [18] conducted a Chemical analysis of the castings and found that it contains 5 times the available nitrogen, 7 times the available potash and 1.5 times more calcium than that found in 15 cm of good top soil. In addition, the nutrient life is up to 6 times more in comparison to the other types of potting mixes. It is reported that phosphorous while passage through gut of worms is converted to the plant available form [17]. It was observed that addition of vermicompost @ 20 t ha^{-1} to an agricultural soil in two consecutive years significantly improved soil porosity and aggregate stability [5]. The number of large, elongated soil macro pores increased significantly after a single application of a dose of vermicompost equivalent to 200 kg· ha^{-1} of nitrogen to a cornfield [13].Vermicompost contains an average of 1.5% - 2.2% N, 1.8% - 2.2% P and 1.0% - 1.5% K. The organic carbon is ranging from 9.15 to 17.98 and contains micronutrients like Sodium (Na), Calcium (Ca), Zinc (Zn), Sulphur (S), Magnesium (Mg) and Iron (Fe) ([19, 20].
Therefore, this research aimed for conversion of vegetable waste into functional compost which is perceived to be eco-friendly.

MATERIAL AND METHODS

The present study was carried out during the Months of December 2019 to March 2020 at CT University, Ludhiana, Punjab.
The earthworms (*Esenia fetida*) used were obtained from the agriculture field present in vicinity of the campus. The vegetable wastes were collected from common households and the hostel mess. Size of the pit was taken into consideration in accordance with the space available and was fixed at 5x5x3 feet, covered with the gunny bags for moisture retention and acts as a barrier.
The Following steps were undertaken with addition of the necessary materials time to time for preparation of vermicompost along with approved precautions:

- Vermicomposting unit should be in a cool, moist and a shady site, so a place with these mentioned features was identified in the agriculture field of the campus.
- A pit of size 5x5x3 was dug and covered with gunny bag so that earthworms could not move into earth. A layer of black soil was kept over it for proper aeration.
- Cow dung and chopped vegetable waste materials were mixed in the proportion of 3: 1 respectively and were kept for partial decomposition for 15 – 20 days.
- After the partial decomposition phase completed, earthworm (27) were released on the upper layer of mixture.
- Water was sprinkled immediately after the release of worms, and was then covered by gunny bags.
- Beds were kept moist by sprinkling of water (daily) below and over gunny bags to retain moisture.
- Beds were turned once after 30 days for maintaining aeration and for proper decomposition.
- Watering should be stopped as the compost gets ready.

  The instrument which was used for measurement of temperature was GREENCO compost, soil thermometer. For measurement of moisture content soil testing kit by Dr. LEPARCO was used and for pH measurement a digital pH meter namely ERMAph030 having measurement range (0-14) was implied.

  Productivity of vermicompost was calculated in percentage using the formula:

$$\text{Productivity of vermicompost (\%)} = \frac{\text{Harvested vermicompost (kg)}}{\text{Total mass of feed(kg)}} \times 100\%$$

RESULTS AND DISCUSSION

The temperature, moisture and humidity in the vermicompost unit were measured weekly and recorded as 25.01°C, 72.32% and 6.78 (average) respectively within the range of 18°c to 30.8°C, 65.5% to 78.8% and 5.8 to 7.6 respectively (Fig. 1 and 2). The net amount of vermicompost produced was 1.2 kg and growth rate of earthworms increased and was recorded to be 312. After the standard process was followed, the waste got converted into useful compost in 55 days. It was harvested when raw material was completely decomposed. The color appeared black while texture was granular. The end product was 3/4th of the raw materials used (Table 1 and fig 3).
According to Harender and Bhardwaj, [7], *Eisena fetida* can multiply by 28 times, i.e. 256 worms, every 6 months from a single individual, double their population every 60–70 days. Earthworms are hermaphrodites and they can double their population in one month in ideal conditions of temperature, moisture, and food, which is organic, matter. Survival and development of earthworms is highly influenced by environmental factors like temperature, bed moisture, rainfall, relative humidity [14] which determines the population in field.

Earthworms accelerate organic matter degradation by increasing the available surface area of organic matter [8]. Reference described that under favorable conditions of temperature (20–30^{0}C) and moisture (60–70%), about 5 kg of worms (numbering approximately 10,000) can vermiprocess 1 ton of waste into vermicompost in just 30 days. Earthworms" body work as a biofilter", and they have been found to remove the biological oxygen demand (BOD) by over 90%, chemical oxygen demand (COD) by 80–90%, total dissolved solids (TDS) by 90–92% and the total suspended solids (TSS) by 90–95% from wastewater. Most significant is that there is no sludge formation [20].

The darkening of soil mould is a slow process, which involves mainly chemical reactions and microbial activity. This process, nevertheless, may be accelerated by earthworms that prepare the soil and litter mixtures composed of fragmented and macerated leaves and fine soil particles for microbial attack. It is well known by vermicompost producers that humus can be obtained from organic matter within a few months [4]. One of the most important roles of earthworms in soil may be their control of humification rates through feeding, burrowing and casting activities and interactions with microorganisms [2, 12,].

TABLE 1: Harvest data of vermicompost during study period

S.No	Parameters	data
1	Total cow dung used	3kg
2	Total vegetable waste used	1kg
3	Initial no. of earthworms used	27
4	No. of earthworms at the time of harvest	312
5	No. of preparatory days for the compost	55 days

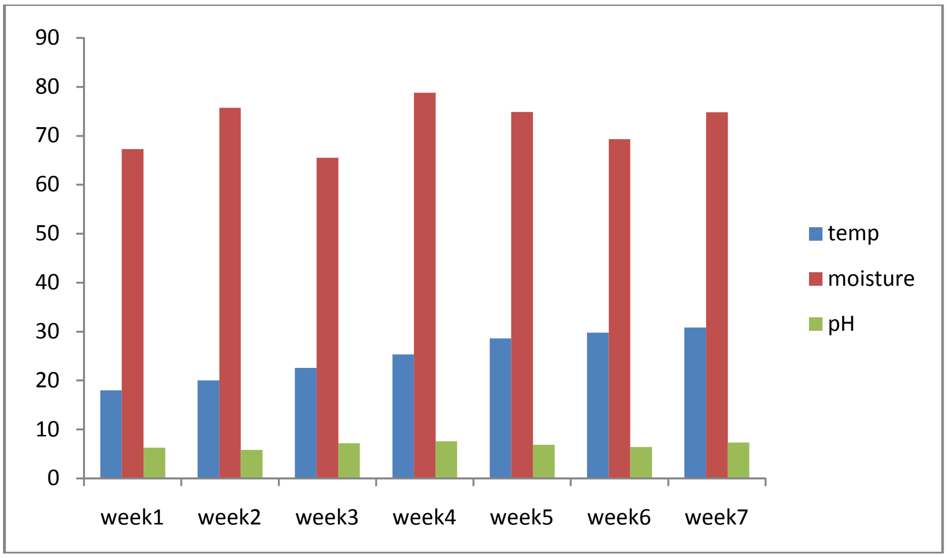

Fig.1: Temperature, moisture and pH changes during 7 weeks of vermicomposting

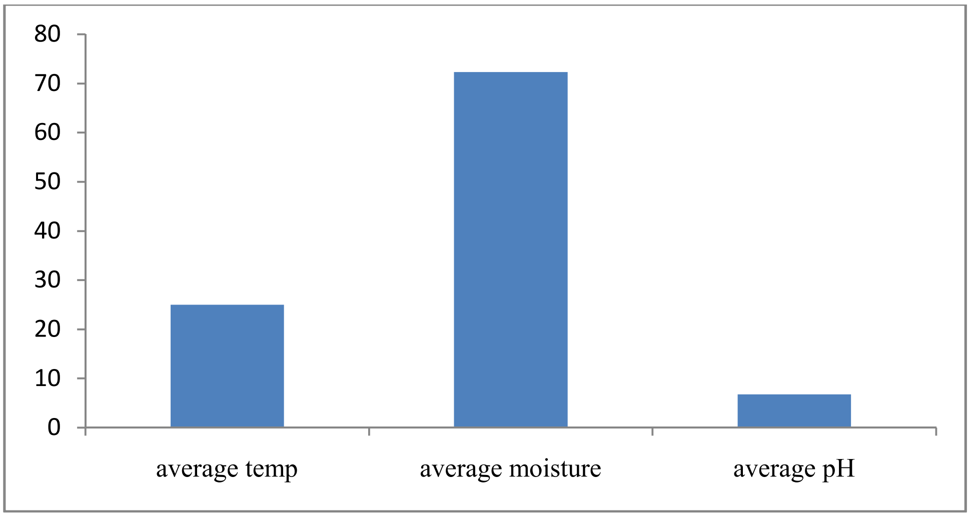

Fig:2: Average temperature, moisture and pH during vermicomposting

Fig:3: Different stages of vermicompost using cow dung, vegetable waste and *Eisena fetida*

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