RESEARCH ARTICLE OPEN ACCESS

Composting Organic Kitchen Waste with Worms for Sustainable Kitchen Waste Management

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ABSTRACT
India produces around 3000 million tons of organic waste annually. This huge volume of waste(s) comes from agriculture, urban and industrial sources and also from domestic activities. Utilization of this waste material for productivity process is important for both economical and environmental reasons. In the present study an effort has been made to assess the efficacy of E. foetida (red tiger worm) in utilizing the kitchen waste material, to analyse the waste decomposition process assessed with earthworm activity.
Keywords **-** Vermicomposting, composting, earthworms E.foetida.

I. INTRODUCTION

Due to increasing in population, rapid industrialization and trend of urbanization, the problem of various types of man- made waste products are gradually increasing. There are different types of wastes like solid, liquid and gas, which are needed to be handled and the solid waste management itself covers a vast field. Solid wastes are produced at different sources i.e. institutional, commercial, agricultural and industrial. Utilization of these waste materials for productivity process is important for both economical and environmental reasons. Agricultural waste, city garbage and kitchen waste has been recycled with vermicomposting along with bio-conversion of organic waste material into nutrition rich vermicompost by earthworm activity [1]. Vermicomposting is an important aspect as it converts waste to wealth by using cheap eco-friendly option with activity of earthworm.

Every home kitchen generates food scraps for disposal. Throwing these scraps in the garbage can create odor problems and adds to the volume of waste going to the landfill [2]. Disposing of kitchen scraps in a garbage disposal is convenient, but it adds to the burden of the waste-treatment system and throws away a potentially valuable resource [2]. Furthermore, garbage disposals are not recommended for homes that rely on a septic system for waste disposal. A viable alternative to disposing of food scraps in the landfill or the sewer system is to compost them. The resulting material is a useful addition to gardens and potted plants.

II. VERMICOMPOSTING- PRODUCTION AND PRACTICES

Vermicomposting is a method of preparing enriched compost with the use of earthworms [2]. It is one of the easiest methods to recycle agricultural wastes and to produce quality compost. Earthworms consume biomass and excrete it in digested form called **worm casts.** Worm casts are popularly called as **Black gold.** The casts are rich in nutrients, growth promoting substances, beneficial soil micro flora and having properties of inhibiting pathogenic microbes. Vermicompost is stable, fine granular organic manure, which enriches soil quality by improving its physicochemical and biological properties. It is highly useful in raising seedlings and for crop production. Vermicompost is becoming popular as a major component of organic farming system.

In vermicomposting, the primary agents of decomposition are worms. They convert raw organic wastes to a nearly stable humus-like material. The main process by which organic materials are converted occurs as the wastes pass through a worm's gut and are digested by the worm. Worms stir and aerate the waste pile, so that turning is not required. Worms can stabilize organic materials faster than microorganisms because they grind the material, thus increasing its surface area and speeding decomposition by microorganisms. The material that results from the vermicomposting process is called vermicompost. Material that actually passes through the gut of a worm is called castings. Vermicompost contains a large fraction of castings, but some of the material will have decomposed from microorganisms alone, without passing through a worm.

The most common composting worm species in North America is *Eisenia fetida*. Common names for this worm include tiger worm, brandling worm, red wiggler, and manure worm. This worm is a litter dweller; i.e. it likes to live in piles of organic matter such as leaf litter. Earthworms, such as the night crawler, are burrowing worms that live deeper in the earth. They are not composting worms.

2.1 COMPOSTING

Composting is a process by which organic materials, such as kitchen scraps and lawn trimmings are converted from an unstable product, which is likely to further decompose and create objectionable odors, to an increasingly more stable product that will store well without being offensive [1]. A diverse population of microorganisms and invertebrates, called decomposers, performs this process. Various decomposers have different temperature and food requirements, thus the makeup of the population present in a compost system continuously changes as conditions change [1]. Most people think of composting as a pile of organic materials that slowly decomposes and creates heat. This is called *thermophilic* composting because it relies primarily on high-temperature tolerant microorganisms. Another form of composting is called vermicomposting.

2.2 VERMICOMPOSTING MATERIALS

Decomposable organic wastes such as animal excreta, kitchen waste, farm residues and forest litter are commonly used as composting materials. In general, animal dung mostly cow dung and dried chopped crop residues are the key raw materials. Mixture of leguminous and non-leguminous crop residues enriches the quality of vermicompost [3].

There are different species of earthworms viz. *Eisenia foetida* (Red earthworm), *Eudrilus eugeniae* (night crawler), *Perionyx excavatus* etc. Red earthworm is preferred because of its high multiplication rate and thereby converts the organic matter into vermicompost within 45-50 days. Since it is a surface feeder it converts organic materials into vermicompost from top.

TABLE 1
Important Characteristics of Red Earthworm (Eisenia Foetida)

Sr No	Characters	Eisenia foetida
1.	Body Length	3-10 cm
2.	Body Weight	0.4-0.6 g
3.	Maturity	50-55 days
4.	Conversion Rate	2.0q/1500worms/2 months
5.	Cocoon Production	1 in every 3 days
6.	Incubation of cocoon	20-23 ays

III. METHODS OF VERMICOMPOSTING

Vermicromposting is done by various methods, among them bed and pit methods are more common.

Bed method*:* Composting is done on the pucca / kachcha floor by making bed (6x2x2 feet size) of organic mixture.

Source: ICAR
Fig 1 : Bed Method

Pit method: Composting is done in the cemented pits of size 5x5x3 feet. The unit is covered with thatch grass or any other locally available materials. This method is not preferred due to poor aeration, water logging at bottom, and more cost of production.

Source: ICAR
Fig 2: Pit Method

IV. PROCESS OF VERMICOMPOSITNG

Following steps are followed for vermicompost preparation

- Vermicomposting unit should be in a cool, moist and shady site
- Cow dung and chopped dried leafy materials are mixed in the proportion of 3: 1 and are kept for partial decomposition for 15 – 20 days.
- A layer of 15-20cm of chopped dried leaves/grasses should be kept as bedding material at the bottom of the bed.
- Beds of partially decomposed material of size 6x2x2 feet should be made.
- Each bed should contain 1.5-2.0q of raw material and the number of beds can be increased as per raw material availability and requirement.

- Red earthworm (1500-2000) should be released on the upper layer of bed.
- Water should be sprinkled with can immediately after the release of worms.
- Beds should be kept moist by sprinkling of water (daily) and by covering with gunny bags/polythene.
- Bed should be turned once after 30 days for maintaining aeration and for proper decomposition.
- Compost gets ready in 45-50 days.
- The finished product is $3/4^{th}$ of the raw materials used.

V. NUTRIENT CONTENT OF VERMICOMPOST

The level of nutrients in compost depends upon the source of the raw material and the species of earthworm. A fine worm cast is rich in N P K besides other nutrients. Nutrients in vermicompost are in readily available form and are released within a month of application.

TABLE 2

Nutrient content of vermicompost

Sr No.	*Nutrient Analysis of Vermicompost*	
	Parameters	Content
1	pH	6.8
2	OC%	11.88
3	OM%	20.46
4	C/N Ratio	11.64
5	Total Nitrogen (%)	1.02
6	Available N (%)	0.50
7	Available P (%)	0.30
8	Available K (%)	0.24
9	Ca (%)	0.17
10	Mg (%)	0.06

VI. FORMATION OF CORRECT ENVIRONMENT FOR *EISENIA FETIDA*

Successful vermicomposting requires a worm bin that provides the appropriate environmental conditions for worms [2]. Worms breathe through their skin and require an environment that is moist, but not so wet that they drown. The material in which they live should feel like a damp sponge and release a few drops of water when squeezed.

Various worm species have different temperature requirements. *Eisenia fetida*, the one recommended for a composting worm bin, can survive at temperatures between 35° and 100°F but performs best between 65° and 78°F [2].

Worms do not have eyes, but they do have light receptors on their skin [2]. They do not like light, and will quickly dig down into a bin to avoid it. For this reason, it is a good idea to provide a cover for your worm bin.

6.1 BUILDING A WORM BIN

You can purchase a worm bin or you can build your own. Two things to consider when selecting a bin design are the amount of food scraps you generate and where the bin will be located [4].Amount of food scraps will determine the size bin you need, and location will determine whether or not the bin needs to be insulated.

A good rule of thumb for sizing a worm bin is this: you can process one-half pound of food scraps per day for each square foot of worm bin surface area. For example, a bin that is 18 inches by 24 inches (18/12 x 24/12) is 3 square feet in surface area and can process about 10.5 pounds of food a week (3 sq ft x 1/2 lb/ft sq/day x 7 days/week = 10.5 lbs).

Worms can survive over a wide range of temperatures, but temperatures below freezing or above 100°F can kill them. If your worm bin will be in a location where the temperature is moderated such as a garage, mudroom, basement, pantry, or under a sink, then you do not need to worry about insulating it. If the bin is to be out doors all winter, it is a good idea to insulate it or bury it in the ground to help prevent it from freezing.

A worm bin must be open enough to allow for good aeration. The bin should include a cover to minimize the attraction of fruit flies and other pests, but if a plastic lid is used, be sure and drill holes in it so air can get in. If the bin is inside or in a location where seepage would be a problem, it should include provisions to catch any liquid that might drain through. Bins can be made of a variety of materials—wood and plastic are common.

The simplest way to construct a bin is to purchase a plastic storage container, drill holes in the bottom and lay down a piece of fabric, e.g. nylon, inside the container to prevent the vermicompost from falling through the holes. The container can be placed on top of its lid with the lid turned up to catch any liquid that might seep out through the bin. If you use the lid as a catchment tray, then a piece of cardboard cut to fit directly on the top surface of the bin will make an excellent cover for the bed. If you want to use the original storage container cover for the lid to your worm bin and devise something else to use as the liquid catchment tray, be sure and drill holes in the lid to allow air into the bin. Even if you use the plastic container lid with holes on top of the bin, it is still a good idea to place a piece of

cardboard directly on top of the worm bin surface to discourage fruit flies from entering the worm bin.

6.2 TROUBLESHOOTING A WORM BIN

i. Foul Odors:

A well-functioning worm bin is virtually odorless. Vermicompost has a faint earthy odor. If your bin has a foul odor it is most likely due to one of the following causes:

ii. The bin is too wet:

Do not add excessively wet food, such as watermelon rind, squashes, etc., to the bin. Mix in dry bedding and/or leave the top off to increase drying.

iii. Overfeeding:

Stop feeding the bin for one to two weeks and see if the problem is solved.

iv. Food is exposed:

Try burying the food under a one-inch layer of bedding. Alternatively, you can add moist bedding on top of the feed.

v. Not enough air:

Make sure there are adequate holes in the bin for ventilation. Fluff the bedding or add additional bedding.

vi. Bin Attracts Flies:

A vermicomposter contains living organisms other than worms. Fruit flies cause the most complaints. To avoid flies, bury the food in the bin and do not over feed it. Keeping the bin covered will also reduce fruit flies.

vii. Worms Are Crawling away from the Bin

When a worm bin is drastically disturbed, such as at start up or when vermicompost is removed from the bin, it is not unusual for the worms to crawl out. This can be prevented by leaving the bin in a lit area because worms will not crawl into the light. It is unusual for the worms to crawl out of an established bin if the environmental conditions are correct

viii. Worms Are Dying

If the bin smells like dead fish, the worms may be dying. Typically, the bin may be too wet, too dry, too hot, or too cold or it may need more air.

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organic waste composting as an alternative to. reduce waste for landfill disposal [12, 13]. Temperature, moisture content, nutrient contentÂ for the trial was kitchen waste with various. combinations. A thin layer of top soil (5cm) was.Â worms were collected from a goat farm. Kitchen waste without any additives was the slowest. to degrade since it contained various materials which. were unfavourable to worms including oil, spices and. others. With additives, this unfavourable has lesser. effects as a result to reaction of kitchen waste and the. additives. It was also observed that inclusion of. Worm composting is a great way for anyone with limited space to turn kitchen waste into compost for the garden or houseplants.Â The common earthworm is not the kind used to produce the rich organic waste known as worm compost.The type most commonly used are red wigglers also called brandling worms or manure worms. They reproduce quickly in the confines of a worm bin. Start out with at least 1,000 worms (18 oz) in weight.