

Review Article

<https://doi.org/10.20546/ijcmas.2020.910.206>

Management of Various Types of Waste Using Vermiculture

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ABSTRACT

Keywords

Vermicomposting,
Earthworm, Waste
management,
Degradation

Article Info

Accepted:
15 September 2020
Available Online:
10 October 2020

Waste materials developed by industrialization, agriculture and domestic activities is a serious problem nowadays and the modern technologies used for its management has ill effects on the environment and health. Vermicomposting is an ecofriendly, pollution free and cost effective methodology which may solve the problem of processing and management of the waste to a larger extent. Earthworms are the key invertebrate present in the soil helpful in decomposition of organic matter and waste, producing bio-fertilizer. The microflora in the intestine of the worm and gut enzymes along with the microflora present in the waste are involved in the degradation of different types of organic biomass into value added materials. This paper talks about how vermiculture is constructive solution to manage solid waste.

Introduction

Earthworms are intestine of the earth, as said by Aristotle, is confirmed and found correct even today. The science of breeding and raising earthworm is called as vermiculture, which in turn used to manage solid waste. With the increase in the population, industrialization, agriculture and domestic activities there is tremendous generation of solid waste and with this increase comes an increased need for management of wastes. Vermicomposting technology is globally popular to manage the solid waste (Gomez-Brandon *et al.*, 2012; Manyuchi *et al.*, 2013). Vermicomposting is a simple biotechnological process of composting, in

which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product (Saranraj and Stella, 2012). In this technique bioconversion of solid waste into a bio-fertilizer or vermicompost takes place due to the activity of earthworm (Manyuchi *et al.*, 2012). It is a simple, inexpensive, energy efficient and ecofriendly technique.

Vermicompost is obtained from a wide variety of organic waste including residual sludge; when sewage sludge is managed with vermicomposting techniques, the resulting product supplies nutrients, more stable organic matter and works as a soil conditioner (Del Aguila Juárez *et al.*, 2011). This review

deals with how earthworms help to solve the problem of solid waste management.

Species of earthworm used in vermiculture

Until the end of the 20th century, there was a counting of 3500 earthworm species known to man (Bohlen, 2002; García, 2006). It belongs to Phylum Annelida, Class Oligochaeta, most of the species belongs to family Lumbricidae. The various species used in vermiculture are *Allophora*, *Aporrectodea*, *Bimastos*, *Dendrobaena*, *Lumbricus*, *Megascolex mauritii*, *Eisenia fetida*, *Eudrilus eugeniae*, *Perionnyx excavatus*, *Lampito mauritii*, *Eisenia andrei*, *Lampito rubellus* and *Drawida willis*, etc. (Palsania *et al.*, 2008; Chanda *et al.*, 2011; Gurav and Pathade, 2011; Shweta, 2011) *Eisenia fetida* known as redworm, brandling worm, red wiggler worm is the first choice for vermicomposting as it is adaptable to changing conditions (Suthar, 2009a; Liu and Price, 2011; Singh and Suthar, 2012; Gark *et al.*, 2005; Kumari *et al.*, 2011).

Process of vermiculture

Vermiculture is a simple biotechnological process of composting in which certain species of earthworms are used to enhance the process of waste conversion and produce a better end product i.e. vermicompost (Saranraj and Stella, 2012).

In the process of feeding, earthworms fragment the waste substrate, enhance microbial activity and the rates of decomposition of the material, leading to a composting or humification effect by which the unstable organic matter is oxidized and stabilized. The end product, commonly termed vermicompost and obtained as the organic wastes pass through the earthworm gut, is quite different from the parent waste material.

The role of earthworm in the process of vermicomposting of waste is a physical and biochemical process. The physical process include substrate aeration; mixing as well as actual grinding while the biochemical process is influenced by microbial decomposition of substrate in the intestine of earthworms various studies have shown that vermicomposting of organic waste accelerates organic matter stabilization (Frederickson *et al.*, 1997) and give chelating and phytohormonal elements which have a high content of microbial matter (Arancon *et al.*, 2005) and stabilized humic substance.

Products of vermiculture

The process of vermiculture mainly produces earthworm as a product, further the vermicompost and vermiwash are the by-product of vermiculture. The vermicompost and vermiwash can be utilized as bio-fertilizers (Manyuchi *et al.*, 2013).

Earthworm

During the process of vermiculture proliferation of earthworm takes place. It can be observed by gain in biomass of earthworm, production of cocoon, weight gain, increase in length of worm and in number and growth rate of the worm (Lim *et al.*, 2012). The proliferation of the earthworm depends upon the temperature, feed type, stock density of earthworm, water contained and feedstock loading rate, etc. The production of worm biomass can also be considered pro-biotic feed for fishery, poultry industry (Nair *et al.*, 2008).

Vermicompost

Earthworms consume raw materials and excrete it in digested form called worm cast or vermicompost which is rich in nutrients, growth promoting substances, beneficial soil

micro flora etc. It is an odourless, dark brown coloured bio-fertilizer (Aalok *et al.*, 2008). Vermicompost are finely divided peat-like materials with high porosity, aeration, drainage, and water-holding capacity. Vermicompost contain nutrients in forms that are readily taken up by the plants such as nitrates, exchangeable phosphorus, and soluble potassium, calcium, and magnesium

(Saranraj and Stella, 2012). Various types of organic waste have been reported to produce vermicompost and a range of nitrogen (N), phosphorous (P) and potassium (K) content were obtained. The quality of the vermicompost is measured by the vermicompost biodegradability coefficient (Garg and Gupta, 2011).

Table.1 Solid waste feed stocks, species of earthworm used in vermicomposting and periods of vermicomposting

Solid waste feed stock used	Species of Earthworm used	Vermicomposting period	Reference
Wood waste	<i>Drawida willis</i>	40	Shweta, 2011
Sugarcane bagasse	<i>Eudrilus eugeniae</i>	48	Palsania <i>et al.</i> , 2008
Temple waste	<i>Eudrilus eugeniae</i>	30	Gurav and Pathade, 2011
Sewage sludge and waste paper	<i>Eisenia fetida</i>	28	Ndegwa and Thompson, 2001
Bio solids	<i>Eisenia fetida</i>	25	Ndegwa and Thompson, 2000
Vegetable market Solids	<i>Eisenia fetida</i>	60	Suthar, 2009a
Food industry waste	<i>Eisenia fetida</i>	117	Garg <i>et al.</i> , 2011
Kitchen wastes and agro waste	<i>Eisenia fetida</i>	50-60	Suthar, 2009b
Waste coffee	<i>Eisenia fetida</i>	72	Liu and Price, 2011
Herbal pharmaceutical waste	<i>Eisenia fetida</i>		Singh and Suthar, 2012
Animal waste	<i>Eisenia fetida</i>	50-70	Gark <i>et al.</i> , 2005
Herbal industry waste and cow dung	<i>Eudrilus eugeniae</i>	62	Kumari <i>et al.</i> , 2011
Soybean husk	<i>Eudrilus eugeniae</i>		Lim <i>et al.</i> , 2011
Rice husk	<i>Eudrilus eugeniae</i>	63	Lim <i>et al.</i> , 2012
Leaf litters	<i>Eudrillus eugeniae</i> and <i>Lampito mauritii</i>	60	Sundaravaidevelan <i>et al.</i> , 2011
Municipal sewage sludge	<i>Eisenia fetida</i>	60	Suthar, 2009a

Vermiwash

Vermiwash is one the by-product of vermiculture industry. It is an organic drainage obtained from units of vermicompost (Das *et al.*, 2014). It is a dark brown colored liquid resulting in washing of the live and

dead earthworms, soil microorganisms and decomposed organic matter, carries all the dissolved substances. Vermiwash is rich in dissolved nutrient and amino acid. It is used as a source of plant nutrient in organic agriculture (Das *et al.*, 2014). The quality of vermiwash produced by earthworms depends

on the vermicompost that is used (Sreenivas, 2000). It is a non-toxic and ecofriendly compound, which arrests the bacterial growth and forms a protective layer for their survival and growth. Vermiwash at 5-10 percent dilution inhibits the mycelial growth of pathogenic fungi. It also has the capacity to encounter worms thereby saving the crops and their productivity. As a foliar spray, it was reported to initiate flowering and long lasting inflorescence. It can also be used as a liquid fertilizer applied to the rhizosphere. No pathogen can survive in this fluid, thereby protecting the earthworms from the diseases caused by pathogens. It acts as a plant tonic and thus helps in reducing many plant pathogenic fungi. It increases the rate of photo synthesis in crops/plants. It also increases the number of micro-organisms in the soil which helps in decomposing soil organic matter (Tripathi *et al.*, 2005).

Management of solid waste

Earthworms have over 600 million years of experience as waste and environmental managers of bio-waste (Sinha *et al.*, 2010). Proper treatment of solid waste has become one of the most important concern in the protection of environment. Among the possible technologies vermiculture offers an environmentally sustainable solution for solid waste management.

Vermicomposting has been done for various wastes including wood waste, sugarcane bagasse, temple waste, sewage sludge and waste paper, bio solids, vegetable market solid, food industry waste, kitchen wastes and agro waste, waste coffee, herbal industry waste and cow dung, soybean husk, rice husk, leaf litters and municipal waste, etc. over vermicomposting periods ranging from 28-120 days using different species of earthworms (Rai and Singh, 2010; Punde and Ganoker, 2012). Table 1 showed different

types of solid waste feed stock used for vermicomposting and the period of vermicomposting.

In conclusion the vermiculture is a revolutionary technology for total and sustainable solid waste management virtually creating 'wealth' from the 'waste'. The products of vermiculture such as vermicompost and vermiwash are used as bio-fertilizers for ecofriendly farming. The earthworms can be further used in further vermicomposting and other technologies like vermifiltration and vermi-remediation.

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How to cite this article:

Kashmiri, Z. N. 2020. Management of Various Types of Waste Using Vermiculture. *Int.J.Curr.Microbiol.App.Sci*. 9(10): 1707-1712. doi: <https://doi.org/10.20546/ijemas.2020.910.206>