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Municipal solid waste management of Ujjain city by on site vermicomposting technique: A review

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Abstract
Now a days a growth of population leads to a substantial increase in MSW. MSW in countries like India is a major problem of health as well as disposal. In this paper undergo the detailed study of vermicomposting techniques. This can be implemented at a basic level of a colony or house hold so the transportation and disposal charges can be lowered also less manpower will be needed. After the reaction are over be can use the end products in our kitchen garden or can be sold in market easily, so the proposal of this technique is very important for further civilization of mankind.

Keywords: MSW, Vermicomposting, Transportation, Manpower, Mankind.

Introduction
Ujjain is a holy city situated at heart on India in M.P.; solid waste is generated in the urban area, which includes the impact of the floating population to Ujjain city. The population density of Ujjain city 330 people per square Km. and the total solid waste generated in the city 226 ton per day. Waste generation estimates suggest that about 63% of generated waste collecting from individual household (MSW). Large amount of money is in the collection and transport of this waste to trenching ground situated at 20 Km. apart from the city. There is a strong decline in the standard of services with respect to collection, transportation and disposal. The major contributors of solid waste are domestic and commercial places, (Sharma *et al*., 2017) [14]. Land filling are not a good option in the developing countries are going for different techniques other than land filling as they experienced the hazards of land filling (Kostecka, and Paczka, 2006) [32]. Vermicomposting in future will be one of the best, techniques for treatment of municipal solid waste (MSW). Decentralization of solid waste collection also leads to an economic and a viable technique and also helps in Vermicomposting of MSW. The participation of private and public sector is necessary to increase the use of this technique. The present study of vermicomposting explores the possibility of using earth worms for treatment of municipal solid waste and we came to a pleasant conclusion about 65% of the volume is reduced in 36 days through Vermicomposting (Dalal, 2012) [13]. Organic farming is involving the uses of natural organic input (Purohit and Gehlot, 2006) [42].

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A review on vermicomposting
The application of an earth worm degrading municipal solid waste (MSW). In this research the condition for process pH needed is 7.0-7.3, temperature 20°C to 35°c and moisture content 45-55% as in this optimization environment the earth worms can degrade about 90 gram worms per kg municipal solid waste (MSW). The result of study explain that the organic solid waste is been treated in a period of 35-36 days by Vermicomposting and the volume of municipal solid waste (MSW) reduces to 35 percent of total volume (Dalal, 2012) [13]. The degradation and stabilization of organic material using by earth worms are call as vermi composting and product are call vermicompost (Dominguez *et al*., 2000) [15]. Eisenia foetida, also known as red wrigglers and *Eisenia Andrei* are two of the most common type of earth worms used for the vermicomposting process. In addition to the earth worms, in vermicomposting process includes micro-organisms; however, earth worms are major contributors in process (Dominguez *et al*., 2003) [16].

Windrows type are used for the large scale vermicomposting process and Windrows are generally built outdoors on a concrete sloped surface for a drain water and avoid pests. A typically height of windrow is three ft. or less and a distance between each windrow is no more than twenty ft. (Sherman, 2002) [46]. (Garg *et al*., 2006) [22-23] a mixed kitchen waste, agro-residue and institutional waste are separated with the cow dung and soil in the ratio of 6:3:1 (dry weight basis).Furthermore, this mixture was partially decomposed for 15 days, according to the vermicomposting process using the K fetida type of worms for 85 days. The results showed lower organic carbon (C) and pH in the product and suggested that this was due to the production of carbon die oxide (CO_2). However, an increase in electrical conductivity along with the total N, P and K, was also reported that and it was concluded that the worm casts obtained from the textile industrial waste contain the highest amount N and P contents, when compared to the institutional waste, agro-residue and kitchen waste.

General characteristic of vermicompost and vermiculture

Vermicompost is the product made by the help of the earth worm, they are capable for improving soil health and the nutrient status. Vermiculture is a process or technique in which all types of the waste biodegradable such as farm wastes, kitchen wastes, market wastes, bio-wastes of agro based industries etc. are converted into nutrient rich vermicompost while passing through the worm-gut. Earth worms are used act as biological agents for consume the wastes and to deposit excreta in the process are known as vermicompost (Adhikary, 2012) [1]. Vermicompost which is also termed as a vermicasts is produced together with vermiwash (Manyuchi and Phiri**,** 2013) [37]. Vermiculture are include earth worms mass production for the waste degradation and composting with vermicast production. Feed of earth worms is organic matter and they utilize a small amount for body synthesis and excrete the large part of consume material are partially digested form as worm cast (Sharma *et al*., 2009) [45]. The vermicompost and vermiwash can be utilized as a bio-fertilizers (Manyuchi *et al*., 2013) [37]. Factor affect in process on vermicompost are control the culturing and earth worm growth of which the most important are food, moisture, light, temperature, pH, and protection from predators (Gajalakshmi and Abbasi, 2003) [20].

Vermicomposting

Vermicomposting process are simple and easy biotechnical process, in which utilization of certain species such as earth worms to enhance the process of Biodegradable waste conversion and produce a best product are called vermicompost. Vermicomposting process are different from composting in some ways (Gandhi *et al*., 1997) [21]. It is a mesophilic process that utilizes microorganisms and earth worms. Worms are active at temperature 10 ˚C to 32 ˚C. The process is faster as compare to the composting process; because of the material are passes through the earth worms gut, a significantly but not a fully understood conversion takes place, whereby the resulting earth worm castings (worm manure) are contain a rich nutrient in microbial activity and the plant growth regulators, and fortified with the pest repellence attributes as well as good. In other words, call the earth worms a type of biological alchemy are capable to conversion for garbage into the "gold" (Vermicomposting technology for waste management and agriculture, 2001 and Tara Crescent Vermicomposting, 2003). Vermicomposting derived liquids from the process are used to irrigation system for providing more nutrients to plant through fustigation which is called a technique of combining fertilizing and irrigation. Nutrients are completely soluble in water therefore will have no risk of clogging up the sprayer (Quaik and Hakimi Ibrahim, 2013) [43].

Precaution during the process

The following precautions should be taken during the vermicomposting process:

- The performance of African species of earth worms, Eisenia fetida and Eudrilus eugenae are ideal for the preparation of vermicompost process. Most Indian species are not prefer for the process because they are not suitable.
- Only plant-based materials including in biodegradeble category such as grass, leaves or vegetable peelings should be utilized in the preparing vermicomposting process.
- Animal origin material such as eggshells, meat, bone, chicken droppings etc are not good for process. It is not suitable for preparing vermicomposting process.
- The gliricidia lopping and tobacco leaves are not suitable for the rearing worms in the process.
- The earth worms should be protected against birds, termites, ants and rats and other their enemy.
- It is very important point in process the adequate moisture should be maintained during all time of the process. Either stagnant water or lack of moisture content could kill the earth worms.
- After the completion of the process, vermicompost should be removed from the bed at regular intervals and replaced by the fresh waste materials (Nagavallemma *et al*., 2004) [40].

Nutrient in vermicompost

The vermicompost are a good and ideal process of soil additive made up of digested compost. A worm casting is much high in nutrients and microbial life and considered as a high value product show in table1.

Table 1: Show the comparison of chemical, microbiological properties of soil and manure or vermicompost (Ahikary, 2012).

Parameters	Nutrient available from		
	Soil	Vermi-compost	Manure
pH	5.96 ± 0.11	8.09 ± 0.09	8.59 ± 0.14
Electrical conductivity ($mS \cdot cm^{-1}$)	0.33 ± 0.04	0.18 ± 0.02	3.05 ± 0.08
Moisture content ($g \cdot kg^{-1}$)	249 ± 4	535 ± 3	864 ± 5
Water holding capacity ($g \cdot kg^{-1}$)	361 ± 4	1103 ± 13	ND
DOC ($mg \cdot g^{-1}$ dry matter)	0.13 ± 0.03	0.60 ± 0.24	15.4 ± 7.91
DN ($mg \cdot g^{-1}$ dry matter)	0.04 ± 0.01	0.07 ± 0.03	1.89 ± 1.07
Total C ($g \cdot kg^{-1}$)	31 ± 1	181 ± 3	299 ± 6
Total N ($g \cdot kg^{-1}$)	3.0 ± 0.3	8.7 ± 0.7	14.2 ± 1.5
C-to-N ratio	10.2	20.9	21.1
NO_3^- ($mg \cdot g^{-1}$ dry matter)	<0.1	<0.1	<0.1
NH_4^+ ($mg \cdot g^{-1}$ dry matter)	<0.1	<0.1	1.0 ± 0.7
P ($mg \cdot g^{-1}$ dry matter)	<0.1	<0.1	2.2 ± 1.6
K ($mg \cdot g^{-1}$ dry matter)	0.9 ± 0.2	1.3 ± 0.1	2.1 ± 0.1
Ca ($mg \cdot g^{-1}$ dry matter)	10.5 ± 3.4	26.3 ± 2.2	0.3 ± 0.1
Na ($mg \cdot g^{-1}$ dry matter)	0.05 ± 0.05	0.21 ± 0.04	0.42 ± 0.02
Background heterotrophic bacteria ($log_{10}CFU \cdot g^{-1}$)	7.85	8.41	8.93
Escherichia coli O157:H7 ($log_{10}CFU \cdot g^{-1}$)	0.00	0.00	0.00
ND not determined.			

Values represent means ± SEM ($n = 3$).

Worm and their biological feature

About 3000 species of earth worms are found worldwide. Out of which, approximately 384 species of earth worms to be found in India (Julka, 1983) [30]. The utilization of earth worms in organic waste management could be achieved when a detailed a good understanding of biology of all useful species and their population dynamics, productivity and life cycles of earth worms are well known (Julka, 2001) [31]. Earth worms are a vary greatly in length. They are known to inhabit in diverse ecological niches. Besides, earth worms are also found in the organic materials just like manures litter, compost, and hydrophilic environments near fresh and brackish water and also in snowy patches (Lavelle, 1983) [34]. The earth worms are hermaphrodites but self-fertilization is rarity and cocoons or eggs are very small varying according to the earth worm. Cocoon color changes with aging naturally. At the age of 6 weeks, the earth worm starts laying cocoons. In the suitable or favorable food and weather conditions one pair of earth worms could produce approximately 100 cocoons in 6 weeks to 6 months (Ismail, 1997) [28]. In the vermicomposting process a few years back it was brought to India and it has been progressively increasing application of animal manure and other forms of biomass (Garg *et al*., 2006) [22-23]. The other epigamic species of earth worms are used in large-scale vermi culture is E. foetida, which has high potential organic waste converting into vermi casts (Garg *et al*., 2006) [22-23].

Different source of vermicomposting

The earth worms are used for the bio-conversion of organic waste into dark brown nutrient-rich humus. Earthworms leave behind while reducing the biodegradable material such a household wastes by vermicomposting turn into a good source of manure for plants and other uses. In some specific cases, the worms could degrade specific pollutants and might allow the community formation of useful microorganisms. Due to low cost nature of inputs is good point but, the price of vermicompost in market is usually low in South Asian countries just like in India it is not good for the growth of process. Earth worms act as a bio engineering principles which could potentially substitute to thermophilic composting is becoming increasingly common and numerous studies have shown that increased plant growth rate and high yield could be achieved when plants grown in the presence of vermicompost (Atiyeh *et al*., 2000 [4], Arancon *et al*., 2004 [6], Arancon *et al*., 2004[6] and Lee *et al*., 2004.) [35].

Vermicomposting from Household Wastes

Several type of container are used to house compost worms for vermicomposting process. Systems can be easy and simple such as a stack of plastic food-storage containers or as complex as an automated unit capable of processing hundreds of pounds of organic matter daily. Generally, each square foot of bin area can process 1 pound of food waste per week (Selden *et al*., 2005) [45]. At the household level, vermicomposting process of food trimmings is becoming

popular enough that a number of entrepreneurs have designed and are marketing home worm bins. Worm composting also is becoming more popular and famous as an educational activity in schools (.Applehof *et al*., 1996) [2].

Vermicomposting of Farm Wastes

Size of pits (2.5 m × 1 m × 0.3) meter (length, breadth and depth) are taken in thatched sheds with sides left open. The sides and bottom of the pit are made by hard compacting and the bottom of the pit layer of coconut husk is spread with the concave side upward to ensure drainage of excess water and for proper aeration process. The husk is moistened, bio waste mixed with the cow dung in the ratio of 8:1 is spread up to a height of 30 centimeter above the ground level and water is sprinkled daily. After the partial decomposition of wastes for 7-10 days. The worms are introduced in numbers/pit. Moisture is maintained at 40 - 50% population density and a temperature is maintained at 20 ˚C–30 ˚C by sprinkling water over the bed. When the compost is ready, it is removed from the pit along with the worms and heaped in shade with ample light.

Harvesting of vermicompost

The bio-conventional composting of organic waste has over vermicomposting is that in the former there is no need to separate the workers from the product. In the process the aerobic bacteria that do most of the work in a bio-conventional composting windrow can be safely ignored when it comes time to spread the finished product are called vermicompost and put it in a small bag. Not so with earth worms they take too long for the reproduce and thus are much too expensive to abandon with each load of product. In the batch type systems such as windrows, it is necessary to either run the product through a worm harvester, or set up the next batch of windrows in such a way that the worms can leave of their own accord (Manual of On-Farm Vermicomposting and Vermiculture).

Application in crop and plant

The glasshouse studies made at CSIRO Australia. They are found that the earth worms increased growth of wheat crops by 39%, growth of grain yield by 35%, lifted protein value of the grain by 12% & resisted crop diseases as compared to the control (Guerrero R.D., 2009 [26] and Baker *et al*., 1997). The impact of the vermicompost and garden soil in different proportion on wheat crops in India. It was show that by impact when the garden soil and vermicompost were mixed in 1:2 ratio proportions, the growth rate was about 72-76% while in the pure vermicompost, the growth rate increased by 82-89% (Krishnamoorthy R.V. and Vajranabhaiah S.N., 1986). Impacts of the vermicompost and inorganic (chemical) fertilizers show that growth rate of strawberries (*Fragaria ananassa*) when applied separately and in combination. Vermicompost was applied @ 10 tons per ha while the inorganic fertilizers (nitrogen, phosphorus, potassium) 85 (N):155 (P):125 (K) kg per ha. Significantly, the result show that yield of marketable strawberries and the weight of the largest fruit was 35% greater than on plants grown on vermicompost as compared to the inorganic fertilizers in 220 days after transplanting due to the effect of compost. Also there were 36 percent more "runners" and 40 percent more "flowers" on plants grown rate by using vermicompost (Bhat J.V. and Khambata P., 1996) [9]. Diseases like a botrytis rot. By suppressing the nutrient related disorders are decreased, vermicompost use increased the yield and quality of marketable strawberry fruits up to 58.6% (Singh *et al*., 2008) [47]. The production and growth rate of vegetable crops like tomato (Lycopersicum esculentus), eggplant (Solanum melangona) and okra (Abelmoschus esculentus) has yielded very good results (Sinha *et al*., 2009 Atiyeh *et al*., 1997 Gupta *et al*., 2008 [26, 47] Guerrero R.D. and Guerrero L.A., 2006) [24]. In addition to vermicompost for increasing plant growth and productivity, vermicompost may also increasing the quality and production of nutritional some vegetable crops such as tomatoes (Gutiérrez *et al*., 2007) [27], Chinese cabbage (Wang *et al*., 2010) [52] spinach (Peyvast *et al*., 2008) [41], strawberries (Coria-Cayupán *et al*., 2009) [10] and lettuce.

Troubleshooting of vermicomposting

Two major problem are created in the process to making of vermicompost first is Death of worms in large and small numbers and second are Bad smells from the vermicomposting grounds. The reason is dying of worms if they are not getting enough food, therefore food should be buried into the bedding. Or food may be too dry, so moisture should be maintained until it is slightly damp. Reason of smell is due to that there is not enough air circulation. In this case, add dry bedding under and over the worms. Turning of the food may give better result. There may be present some materials such as meat, pet feces, or greasy foods, which are harmful in the compost, pit. These should be removed from feed material.

Benefits of vermicompost

The vermicomposting make a rich soil amendment manure using a special combination of organic matter, moisture, and temperature. In the vermicomposting process uses of earth worms to achieve the same goal. Like regular compost, vermicompost also benefits for the environment because it may reduce the demand of chemical fertilizers and decrease the percent of solid waste amount entering for landfills (josan *et al*.). Humid acid are present in the humus provides to binding sites for the plant nutrients, such as calcium, iron, potassium, sulfur and phosphorus (Li *et al*., 2010) [36]. Vermicompost has an ability to fight soil-borne plant diseases such as root rot it is also a plus point of vermi composting. Humus also increases water permeability and water retention capacity, contributing to the better plant health and more efficiently use in soil moisture content. It is found by the result nitrogen (N) concentrations are high in vermicompost than in aerobic compost piles (Ayres, M., 2007) [7]. Microbial activity of beneficial microorganisms in worm castings is 10-20 times high than that of in the soil and other organic matter (Edwards, C.A., 1995). The product has excellent soil structure, porosity, aeration and water retention capacity (Shane, O.K., 2007). The vermicompost makes plants growth rate fast and strong. Nematodes and diseases will not ruin gardens or plants if the soil is rich enough for them to grow faster by using vermicompost. The weak and low growth plant in poor soil that is destroyed from the nematodes and diseases (Gaddie and Douglas, 1975) [19]. Vermicompost also has a positive effect on the vegetable plant growth or other conditons, stimulating shoot and root development (Edwards *et al*., 2004) [3]. Commercial vermicomposting process in California, US, claims that his product repels many different insect pests. His explanation is that this is due to production

of enzymes "chitinase" from earth worms which breaks down the chitin in the insect's exoskeleton (Munroe G., 2007) [39].

Conclusion

After this detailed study of various points and analyzing the MSW management of Ujjain city it was been concluded that implementation of vermicomposting technique is very essential in Ujjain city as in present waste is been disposed using transportations the plants is been situated in Gondia (about 20 kms Northwest) of Ujjain city. The Transportation is done by 80 mini tripper and 40 big dampers so the cost is very high if we apply the vermicomposting technique the 651 volume is reduced in 36 days (Dalal, 2012) [13]. So we reduce the organic matter by a four reactor technique and then will analysis the reduction and cost afterwards.

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