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Review Article

An Overview: Organic Waste Management by Earthworm

Abstract

Vermicomposting is a biotechnological process, in which organic materials converted as valuable product by earthworms. The nutrient profile of vermicompost is higher than traditional compost. The vermicompost alters the soil fertility in different ways, such as better aeration, porosity, bulk density, water holding capacity, pH, electrical conductivity, nitrogen, phosphorous and potassium content. The application of the vermicompost is enriches the soil microorganism, plant growth (size of leaf, height, width and weight) and nutrient content of the yield. The high concentrations of vermicompost may delay plant growth due to the concentration of soluble salts. As a result, vermicomposts should be applied at required quantity to produced higher yield. In this overview describe about the organic waste management, vermicompost, earthworms species and economical importance of the vermicompost.

Introduction

The habitations of human beings and animals generate huge load of organic wastes and their decomposition products affect the quality of soil, air and water. Much of the biosolid wastes are highly infectious as they contain an array of pathogenic microorganisms. Their disposal into the environment without prior disinfection causes health and environmental risks. The animal and municipal waste change the soil character, including pH, bulk density, conductivity, water holding capacity and increased the organic carbon content [1].

The management of biosolid wastes is gaining importance for not only providing clean and healthy environment but also enhancing the primary productivity through soil quality improvement. Composting is the widely accepted process for the recycle in organic wastes; the direct land application of raw wastes or poorly stabilized materials caused toxicity and pathogenicity towards land [2]. Composting is the biological transformation of organic matter into a well-stabilized product through the fast succession of microbial populations under aerobic conditions. The process results in mineralization of organic matter into carbon dioxide and transformation into humic substances [3].

Kumar et al. [4], reported that most of the Indian cities are threading by environmental problem due to solid waste. The solid waste creates many problems in raining season by blocking the running water. Many ways solid waste were managed *viz.*, incineration, composting, gasification, refuse derived fuel (RDF). The organic solid was pulverization and converted into vermicompost; used as fertilizer with economical worth of 9.36 lakhs/year. Sequeira and Chandrashekar [5], reported that household waste of food, paper, vegetable and garden (grass and leaves) with cow dung were converted as vermicompost by *Eudrilus* sp.; the compost having rich beneficial microbial community of bacteria, fungi, actinomycetes, *Pseudomonads*, P- Solubilizers and N2 Fixers. Indiscriminate uses of synthetic chemicals leads to many problems in agroecosytem and affect the non-target organism. Aali et al. [6], reported that agricultural industry waste such as sheep manure, pomegranate peels, mushroom, chopped corn, sugar beet pulp and sawdust were used as raw material for vermibed; and the obtained compost reduced the electrical conductivity, raising pH, and NPK of treated land and act as fertilizer.

Vermicomposting, is a bio-oxidative process in which earthworms interact intensively with micro-organisms in the decomposer community, accelerating the organic matter by stabilization with modified physical and biochemical properties. Vermicomposting differs from conventional composting because the organic material is processed by the digestive systems of earthworms. The digested casts can be used to improve the fertility and physical characteristics of soil. In this process, the earthworms actively participate in the degradation of organic matter by physical and biochemical action. Physical

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participation in degrading of organic substrates results in fragmentation, for increasing the surface area to action and aeration. Conversely, biochemical changes in the degradation of organic matter are carried out by microorganisms through enzymatic digestion, enrichment by nitrogen excrement and transport of inorganic and organic materials. The earthworms contribute significantly in the recycling of organic waste and production of organic manure with high humic contents, which are helpful to maintenance the soil structure, aeration and fertility. The bioactive substances present in the humic acid fertilizer can enhance physiological metabolism, growth, yield, seed germination etc., while these features are absent in ordinary fertilizers. Applying humic acid fertilizer can also effectively increase the anti-drought and ant frigidity potential of crops, and prevent underground plant diseases, insect pests and pathogenic bacteria. The present reviews describe about various aspects involved in vermicomposting of organic waste by different species of worm.

Biology of earthworm

Earthworms are invertebrates of agro ecosystem, belonging to the family lumbricidae, both male and female reproductive organs present in single earthworm, hermaphrodites. At the time of eggs laying, the sexually mature worms contain a distinctive epidermal ring shaped area called, clitellum, which has gland cells that secrete material to form a viscid, girdle like structure known as cocoon. The number of fertilized ova in each cocoon have 1-20 lumbricid worms. There were about 3000 species of earthworms distributed all over world and about 384 species were reported in India [7].

Vermicomposting characteristics and process

It is an aerobic, bioxidation and stabilization non-thermophilic process of organic waste decomposition that depends upon fragments by earthworms, mix and promotes microbial activity [8]. It is a peat like material with high porosity, aeration, drainage, water holding capacity and microbial activity [9-10]. It also enhanc the resistance of plants against pests and diseases. Earthworms can serve as "nature's plowman" and form nature's gift to produce good humus, which is the most precious material to fulfill the nutritional needs of crops [11]. Ramesh et al. [12], reported that organic waste pollution was increased by day to day activities and other side shortage of organic manure, in this connection earthworms were used for conversion of organic waste into vermicompost. Westerman and Bicudo [13], reported that organic waste was used to improve the soil physical and chemical properties with nutrient for cultivation. Nair et al. [14], reported that vermicomposting is a powerful tool for bulk reduction of waste as well as pathogen free vermicompost. The vermicompost reduced the cadmium content of the soil and enrich the soil by maintain the pH, P, K, Na, Ca and microorganism [15]. Shamini et al. [16], reported that in Malaysia produced more than 70% solid waste, while 95% disposed in landfill; it was not properly managed and caused nuisance. Some of the waste was converted as methane by anaerobic; it leave global warming, in this case, earthworm was used for organic waste management without environmental pollution. Tea waste was mixed with soil in different ratio, for conversion as compost by using *E. eugeniae*. The compost provide rich nutrient with microbial content called as fertilizer. The accumulation of organic waste, threat to the environment in all the continent, the waste would be manage the sustainable way by using anaerobic conditions without affecting ecosystem. It may use for biogas production and energy management for day by day usage [17]. Lim et al. [18], sated that soybean husk and papaya waste were studied in different ratio for waste management with *E. eugeniae*. Among the different ratio 1:1 was best combination for vermicompost. All the nutrients of ca, K, mg, and p value were increased while C: N ratio decreased after 63 days. Westerman and Bicudo [13], reported that organic waste was used to improve the soil physical and chemical properties with high nutrient for cultivated plant.

Vermicomposting is an important technique of converting organic waste into nutrient rich compost by earthworms without compromising the population of beneficial bacteria. In recent years, many researcher concentrated to study about vermicompost for sustainable agriculture, the organic waste was converted as vermicompost, the compost have high content of NPK, Carbon, nitrogen, beneficial microorganism and growth hormones [19]. Pathma and Sakhivel [8], reported that vermicompost is process of non-thermophilic, bio-oxidative process with help of earthworm and microbes. Compost enhanced the soil fertility by soil biodiversity richness, water holding capacity and growth regulation hormones.

Dhimal et al. [20,21], reported that compost have high microbial content, required pH, organic matter, moisture content, nitrogen, phosphorous, potassium and Carbon : Nitrogen ratio (C:N) value for agricultural practice. Solid waste management is a big issue in our country; the waste was converted into useful agricultural fertilizer by using earthworm [17]. Kumari [22], reported that vermicompost was done with different ratio 1. Soil + cow dung 2. Soil+ vegetable waste + fruit waste, 3. Soil +vegetable waste + fruit waste + cow dung, 4. Soil+ paper waste+ cow dung and their compost were analyzed TP, TK, TOC, TKN, and C: N parameter. The temperature of the compost, between 21-25 ° C, TP (0.11-0.25%), TK (0.19-0.55%), TKN% (0.33-0.77%), TOC (8.03-22.3%), pH (5.9-6.1) and C: N (10.78-31.68%) was recorded during composting period (0-45 days).

The livestock excretes was managed by sustainable way called as vermicompost. Without earthworm, the composting will take energy losses (used number of man power), while using earthworm it breakdown the manure in very fast and would be recyclable; the vermicompost having high amount of nutrient and microbial biomass. Compost is a cost important tool for eco-friendly waste management [23]. Kaouachi et al. [24], stated the obtained vermicompost having increased NPK, calcium, magnesium, sodium and required EC and C/N ratio. *Eisenia fetida* was used for biodegradable solid waste management and it is ecofriendly waste management without producing any heat. As suggested that small scale (individual house) waste management is easiest way to solid waste management and economically viable. Also the resulted of raw waste was lower than compost pH. The carbon, phosphorus,

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carbon:nitrogen ratio of the compost was higher than raw waste [25].

Sumi et al. [26], reported that, solid waste management is one of the big environmental issues. The residual and animals waste was pollute the aquatic and terrestrial ecosystem. A quantity of biodegradable solid waste categorized. Such waste modified into environmental safely products by microbial composting, vermicomposting, biogas plant, etc; Vermicompost induced, germination, flowering and fruiting the plants earlier than the control (without vermicompost). The increased micro flora (bacterial and fungal colonies) and NPK content was increased in treatment, when compared to the control. Vermicompost is a simple, cost effective, low maintenance, easy method of waste management. Sadasivuni et al. [27], reported that India reusable organic biomass of 0.7 and 0.8 million tonnes/year. The author stated that potential use areca nut and cocoa waste were managed by vermi technology and without environmental effects; it having higher nutrient than compost; also it induced the soil fertility.

Waste stabilization by vermicomposting

A greenhouse trial was conducted with vermicompost from 1.Raw dairy manure with tobacco residue, 2.yard leaf, 3. Sewage sludge + rice hull, 4. Sewage sludge + yard leaf, and raw dairy manure were evaluated in tomato seedling; all the treatment produced a significant growth than control [28]. Nair et al. [14], reported that kitchen waste was thermo composted for 9 day and converted as vermicompost within 2.5 months. Lokeshwari and Swamy [29], reported that house hold and market vegetable waste were mixed and finally add 0, 10, 20 and 30% of sewage sludge. The mixture was aerobically decomposed for 20 days and *E. eugeniae* was released. Within 30 days, end product was obtained when compared to windrow composting (80 days).

The agriculture waste and cattle manure with different ratio was prepared as vermibed such as 1. Equal weight of (*Penniseumtyphoides* and *Sorghum vulgare*) + sheep manure (1:2 ratio), 2. *Vignaradiata+ Triticumaestivum+* cow dung (1:1:2 ratio), 3. Mixed all the plant + cow dung (1:1 ratio) 4. Cattle shed manure for renewal energy by vermicompost. All the compost has rich N (97.3% to 155%), P (67.5% to 123.5%), K (38.3% to 112.9%), and Ca (23.3% to 53.2%), and decrease in organic C (20.4% to 29.0%) [30]. Gurav and Pathade [31], reported that temple organic wastes with cow dung and biogas digester slurry were decomposed for a period of 30 day at 30° C. After, digestion *E. eugeniae* was introduced at 25° with pH 8.0 and moisture content (80%) should be optimum for high nutrient yield of vermicompost.

Beohar and Srivastava [32], reported that *E. fetida* and *L. mauritii* were used for poultry waste management. Both species produced compost 3rd day onwards. *E. fetida* was performed well when compared to *L. mauritii*; but there was no significant changes in the soil. Lim et al. [33], sated that soybean husk and papaya waste were studied in different ratio for waste management with *E. eugeniae*. Among the different ratio 1:1 ratio was best combination for vermicompost. Dhimal et al. [34], reported that Zoo waste were mainly animal dungs, garbage and litter; converted as compost by using earthworm, the composting period was minimum than traditional compost. African earthworm *E. eugeniae* used as solid waste management. Paper waste contain rich carbon but need nitrogen for that cow dung was used as mixture in different ratio a. 1:1 (paper+ cow dung), b- 2:1 (paper + cow dung), c- 3:1 (paper + cow dung), among the combination 1:1 ratio was best one, the compost was collected up to 65 days excluding 15 days pre digestion. Kaouachi et al. [35], stated that olive wastes was converted as vermicompost by using *E. andrei*. The obtained vermicompost having increased NPK, calcium, magnesium, sodium and required EC and C/N ratio.

Londhe and Bhosale [36], reported that solid waste was managed by earthworm. The waste called as gold, when it was converted as vermicompost and will not produce any kind of risk to the environment. Different ratio of verminbed were T1, soil + cow dung, (0.5:1), T2, soil+vegetable+fruit waste (1:1), T3, soil+agricultural waste+cow dung (1:1) and T4, soil+paper waste+cow dung (1:1). The vermicompost showed increased potash and nitrogen content. Nag et al. [37], stated that 5-75% of organic solid waste collected from religious area of Patna, Bihar, India; it converted as valuable materials by using *E. fedita* and *E. eugeniae*. The result showed that NPK were increased in duration was increased also C/N ratio, carbon% were decreased increasing duration of composting period.

Albasha et al. [38], who have reported that kitchen waste, with combination of cowdung, were predigestion for a period of 15 days. The best compost was obtained in kitchen waste + cowdung (1:1), than Kitchen waste+cowdung (2:1) and Kitchen waste+cowdung (3:1) ratio. The pH value was reduced when duration of the compost collection day increased (0-60 day), total nitrogen (%), phosphorus (%), potassium (%) and carbon: nitrogen ratio were increased considerably. Jain [39], observed that organic solid waste management is major problem in developing countries. Poor management of solid waste is called as environmental pollution. In India most of pilgrims, generated large quantity of waste during the festival. The flower waste was high in some major temple of Jaipur, Rajastan, India. The flower waste was converted as vermicompost with mixture of cattle dung by using *E. foetida*. The waste was converted as vermicompost with 50% of weight was reduced during the vermicompost process. The compost was at 25°C, 8.0 pH, 1-2 mm particle size, moisture 60%, bulk density were acceptable limit. Also compost reduced EC, C: N ratio, C: P ratio and increase in N, P.K, Ca, Mg, and sulphur. The vermicompost used as fertilizer for tomato plant cultivation it enhanced the growth (stem diameter, height, leaf number, length of roots, yield/plant).

Potential applications of vermicompost in plant growth

Vermicompost (cattle manure) was studied in their efficacy on *Petroselinum crispum*, the result indicated that vermicompost enhance the size of leaves, plant height and yield [40]. Kizilkaya et al. [41], reported that earthworm play, a vital role in organic waste management by vermicomposting; the vermibed was prepared in different combination by using sewage sludge amended with hazelnut husk and cow dung. After preparation , the *E. fetida* was introduced in to vermibed and their compost

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was studied on *Triticumaestium*; found that all treatment induced the growth and yield of tested plants when compared to control.

Ansari and Hanief [42], reported that every population released considerable amount of organic waste, it is dumping in landfills (burn or river systems). The river was polluted by plant and large amount of market waste daily. While, the waste was converted as vermicompost (30% yield), huge volume was degreased. For the reason earthworm is a main technology transfer for bio-waste into valuable materials. Also it contains beneficial microorganisms (*Actinomycetes*, *Azotobacter*, *Nitrobacter*, *Nitrosomonas* and *Aspergillus*) for plant productivity. Karmakar et al. [43], evaluated the effect of vermicompost, chemical fertilizer, 50% manure +50% fertilizer and control on rice field. They found that vermicompost showed good growth and provided maximum nutrient to tested plants.

The increasing population, there is need for fertile lands to cultivation. *Mentha arvensis* was cultivated under salt stressed conditions in both controlled and field conditions. The fungi *Glomus aggregatum* and *Exiguobacterium oxidotolerans* with vermicompost improved plant growth. Also concluded multi-microbial inoculations together with vermicompost as efficient biofertilizers for *M. arvensis* cultivation [44]. Xu et al. [45], reported that vermicompost had complex effects on the antioxidant enzyme activities of plants; when it was grown under high salinity. The organic waste of industrial sewage sludge and municipal solid waste compost were mixed with cultivated soil. The both treatment increased the organic matter, microbes, but decreased waster holding capacity in industrial waste, in case of the yield industrial waste was higher than municipal waste treated soil [46].

Masullo [47], reported that waste materials was digested by anaerobic condition then converted as vermicompost by using earthworm. While vermicompost applied in the field, it reduced the irrigation frequency and induced the plant growth. The vermicompost from sewage sludge, wood chips mixture with biochar, induced the higher reproductive rate of earthworm (cocoon, juveniles) and reduced the Zn and cd [48]. Maji et al. [49], reported that humic acid rich in vermicompost, is induced the plant height, fresh weight, dry weight. Also maximum number and density of microbes (bacteria, fungi) were recorded when compared to chemical fertilizer. Different species of earthworms was used for production of vermicompost; and is powerful biofertilizer in sustainable agriculture with reduction of chemical agrochemicals. The worms were involved in waste management by and recycling of organic waste [50].

Conclusion

Vermicomposting is a biotechnological process involved by earthworm; the natural bioreactors playing an essential role in the breakdown of organic matter and maintaining soil fertility. The worms involved recycling of organic waste and enhanced plant growth. The importance of vermicompost is further enhanced as it has simultaneously other benefits; excess worms can be used in medicines and as protein rich animal feed. Finally we conclude that vermicompost reduced the pesticide application, low pest infestation, reduction of irrigation frequency and pesticide free high yield.

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