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Review on Efficiency of Organic Solid Waste Management

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ABSTRACT: Vermicomposting is a functional biotechnique method used for con version of solid organic waste into vermicompost.Vermi technology was examined in order to reduce the organic waste materials. Generation of organic waste has been increased and varies studies revealed that 90% of MS Wisdisposed in open dumps that end in problems to human as well as animals.The compostcontains rich nutrients elements like C, N,Pand K and other physical characteristics (pH, temperature, and moisture content, water holding capacity,bulkdensity and conductivity)willbeanalyzedinthebothstagesi.e before and after the experimental process.Vermi compost enhances soil bio diversity by promoting the beneficial micro organisms (regulating hormones and enzy mes) which in turn enhances germination, plant growth and yield by controlling plant pathogens,nematodes and other pests, there by enhancing plant health and minimizing the yield loss.This paper deals with the explanation of a)It can be used to promote sustain able safe management of agricultural, industrial, domesticand hospital wastes which may otherwise pose serious threat to life and environment.

Keywords:N, P and K, Waste management, Vermicomposting

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I. INTRODUCTION:

India, the world's second highest populated country is considered as one of the fastest urbanizing countries with the annual growth rate of 3.09% of urban population. The proportion of population living in urban areas has increased from 17.35% in 1951 to 26.15% in 1991. Urban development in India has drawn a serious attention towards the areas of MSW management. There has been a significant increase in the generation of MSW in India over the past few decades with every day generation of about 0.1 million tonnes, which is approximately 36.5 million tonnes annually. The 23 metro cities in India generated about 30,000 tonnes of solid wastes per day while about 50,000 tonnes are generated daily from the Class I cities (i.e., with > one lakh population) (Abbasi and Ramasamy, 1999)The per capita solid waste generation rate increased with the size of the city and varied between 0.3 to 0.6 kg/d with record up to 0.5 kg / capita / day in metropolitan areas. The estimated annual increase in per capita waste quantity is about 1.33% per year (Curry, J. P. (1987).). New Delhi, the nation's capital producing 7,700 t per day; Chennai - 3,500 t per day; Bangalore - 2,000 to 2,300 t per day; Hyderabad - 2,200 t per day; Visakhapatnam- 1,000 t per day; Vijayawada - 450 t per day; Pune - 900 t per day; Madurai - 400 to 450 t per day; Pondicherry - 370 t per day; Vellore - 60 to 80 t per day. Moreover, the MSW disposal issues have become challenging as more land is required for its disposal (Anan and Krishnappa, 1988).). According to The Energy Research Institute (TERI) (New Delhi) the annual generation of MSW would be >260 million ton by 2050, which needs an additional area of 1400 km^2 for its disposal, most of it in urban areas. Indian municipalities therefore faced the challenge of rein forcing their available infrastructure for efficient management of MSW.

Soil is the basis of the life in the universe, directly or indirectly. The hope of a healthy world rests on a good, healthy and fertile soil. Therefore, there is an urgent need for rejuvenating the tired, overworked, degraded, polluted and nutritious soil to make it potent for future food production (Atiyehet al., 2000). Man has a role in shaping his environment. He has been responsible for degrading the quality of his environment ever since he appeared on this earth. Environment is our essential resource for development and its optimum utilization and wise management is necessary for progress and national planning. Man's very survival depends on protection and adjustment to the environment(Benik and Bejbaruah, (2004).).

Composting

Composting generally is the aerobic microbial transformation of organic matter (Atiyehet al., 2000), and has been designated as the most adequate method of managing organic wastes or organic fraction of urban solid waste. However, compared to thermal composting, vermicomposting with earthworms often produces a product with a lower mass, lower processing time, humus content, phytotoxicity is less likely, more N is released, fertilizer value is usually greater, and an additional product (earthworms), which can have other uses is produced (Davidson and Stahl, 2006).

Composting system is an environmentally superior and cost-effective alternative to landfill that produces top quality compost. The process of composting ensures that kitchen waste - a significant contributor of every household's bulky volume of garbage - is not thrown (Edwards and Arancon ,2004)). The use of earthworms in waste management by utilizing and breaking down organic wastes has received increasing attention over the last 20 years. The growing recognition in developed countries is that the organic matter in the waste stream can be used as a resource rather than going to landfills where it creates a range of environmental problems that are costly to ameliorate. Composting imitates nature's way of rebuilding soil by encouraging the decomposition of organic substances, but it does so more rapidly because heat, microbes, and the worms combine to speed up the process. Compost prepares the soil for plant roots to penetrate.

Vermicomposting

Vermicomposting helps in 'Low External Input Sustainable Agriculture' (LEISA). The 'Fatigue of the Green Revolution' due to stagnation in yield levels and to a larger quantity of nutrients required to produce the same yield as in the early periods, can now be changed or rejuvenated by eco-technologies like vermicomposting. In the scenario of vermicomposting, waste management and utilization finds an increased welcome space. The emerging techniques make earthworms 'Biomanagers' in worm composting. Vermiculture and vermicomposting in fact help in solid waste management, where organic solid wastes are considered resources.

In India enormous quantities of organic wastes (more than 2500 million tonnes) are being produced annually which could be converted into manure for agricultural purpose (Gajalakshmi and Abbasi, 2002).). It is estimated around 30 per cent of all household waste is the kind of organic material which worms thrive on. If everyone composted in this way there would be 30 per cent less waste going into landfill sites, 30 per cent less waste being transported on the roads with all the associated fuel emissions which coincides with this and subsequently less costs involved in the disposal of waste. During vermicomposting, the wastes are processed into organic fertilizers and at the same time we are getting rid of organic solid wastes.

Earthworm is known to be a good biological element for recovery of vermicompost, vermicast, vermiwash and vermiprotein for the use in agriculture and aquaculture (Gajalakshmi and Abbasi, 2002). Vermicompost is entirely a natural product and has no question of polluting the air and water. Cow dung is the main source of farm yard manure (FYM) which contains 5 to 6 kilo grams nitrogen, 1.5 kilo grams phosphorus and 5 to 6 kilo grams potassium per ton. It also improves the soil health.

Nutrient Value ofvermicompost

The vermicompost is a rich source of nutrients (Kaplan and Hartenstein1980).) and is used as a soil conditioner or fertilizer. Increase in soil nutrients status and nutrients uptake was reported due to application of vermicompost. The nutrient content of vermicompost greatly depends on the input material. It usually contains higher levels of most of the mineral elements, which are in available forms than the parent material (Khan, 1966).(Lee 1985) and (Sing, 1987), found that the earthworm casts contain more nitrogen, phosphorous and calcium than the substrate. The biological activity of earthworms provides nutrient rich vermicomposting for plant growth thus facilitating the transfer of nutrients to plants. Vermicompost contains most nutrients in plant-available forms such as nitrates, phosphates and exchangeable calcium and soluble potassium (Watanabe,1975), that are taken up readily by plants and provide many microsites for microbialactivity and large surface are as for the stronger tention of nutrients (Edwards&Burrows,1988).(Yadav and Kumar, 2005) reported the feasibility of utilization of vermicomposting technology for nutrient recovery from industrial sludge in laboratory scale experiment employing Eiseniafetidaearthworm. As a bioinoculant, vermicompost increased nitrogen and phosphorous availability by enhancing biological nitrogen fixation and phosphorous solubilisation (Parl, (1963 b). Significant increase in the NPK content was found in the vermicompost made from the mixture of vegetable waste and cow dung more NPK in the compost than that in the initial soil(Scheu, 1991).

Microbial characteristics ofvermicompost

Microorganisms are mainly responsible for the biochemical degradation of the organic matter during composting and vermicomposting processes and, in the latter, earthworms play a very important role in both microbial activity and diversity (Frederickson and Knight, 1988).There are very few studies in which a comparison of the microbial community and activity in compost and vermicompost from the same feedstock is made (Handrek, 1986). For the composting processes, the importance of microbial communities is well established (Ismail, 1997b). Due to the mesophilic transformation of organic matter, vermicompost contains greater microbial populations than thermophilic compost, leading to greater potential for odor reduction and nutrient mineralization (Kale, 1998a). Various studies have shown that vermicomposting of organic waste gives chelating and phytohormonal elements which have a high content of microbial matter. Nutrient rich substrate concentration, high moisture level and large surface area of vermicast ideally suited for better feeding and multiplication of microbes (Lee, 1985).

Vermicomposting converts the infected biodegradable waste containing various pathogenic microorganisms to an innocuous matter (vermicompost) containing benificial microorganisms usually found in the soil all over. Earthworms hosts millions of decomposer (biodegrader) microbes in their gut and excrete them in soil along with nutrients nitrogen (N) and phosphorus (P) in their excreta called ‘vermicast’ (Sinhaet al., 2010). (Sinhaet al., 2003) studied the bacterial flora associated with the intestine and vermicasts of the earthworms and found species like Pseudomonas, Mucor, Paenibacillus, Azoarcus, Burkholderia, Spiroplasm, Acaligenes, and Acidobacterium which has potential to degrade several categories of organics.(Edwards 1998) reported that vermicompost is rich in microbial populations and diversity, particularly fungi, bacteria and actinomycetes. (Senet al., 2008) evaluated bacterial community structure and dynamics in triplicate vermicomposts made from the same start-up material, along with certain physico-chemical changes. (Edwards and Burrows, 1988) identified large populations of Gram-negative Enterobacteriaceae in vermicompost feedstock. The predominance of Gram-positive bacteria, both Firmicutes and Actinobacteria, in composts was referred before(Elvira et al., 1995) and may be attributed to the production of thermotolerant spores. Earthworms also can greatly affect fungal communities. Very little is known about fungal communities in mesophilic processes of vermicomposting (Bogdanov, 1996). (Piearce,1972) calculated fungal biomass from the ergosterol content in the vermicompost samples. The research conducted by demonstrates that qualitative and quantitative characterization of compost’s fungalcommunity.

Physico-chemical quality of the feed wastes and vermicompost

The chemical composition of the vermicompost is known to be influenced by the kind of feed given to the animal, bedding material used and the way the waste is collected, stored and handled before utilization (Kumar and Kumar 2011). A detailed review of various physico-chemical parameters of feed material and their influence on the quality of the vermicompost is given in the following section.

pH and EC

Variation in pH of vermicompost has been reported by several workers. The differences in the pH of vermicompost are directly dependent on the raw materials used for vermicomposting. Different substrates could result in different intermediates and hence show a different behaviour in pH shift. The neutral pH recorded throughout the bed profile is optimal for the growth of Ei. fetida(Joshi and Sharma, 2010). The occurrence of acidic environment may be attributed to the bioconversion of organic acids or higher mineralization of the nitrogen and phosphorous into nitrites /nitrates and orthophosphate, respectively .The pH of cow dung and sheep manure vermicompost came out to be 8.48 and 8.6(Lee, 1985).cattle manure had a pH of 6.0 - 6.7 (Szczeck, 1999).pig manure had a pH of 5.3- 5.7 and the one derived from sewage sludge had a pH of 7.2 (Vasanthiet al., 2013). The lower pH of the final vermicomposts might be due to production of CO_2 and organic acids by microbes during the process of bioconversion of different substrates in the feed given to earthworms. The decline in pH may be directly related to reduction in volatile solids and to the growth of earthworm’s biomass. The larger the increase in biomass growth, the greater the reduction in volatile solids and the more shift towards the acidic condition (Nielson ,1965). A decrease in pH may be an important factor in nitrogen retention as this element is lost as volatile ammonia at higher pH value. The lower pH was due to production of fulvic acid and humic acid during decomposition. The change of mesophillic to thermophillic condition changes pH from acidic to alkaline due to conversion of organic –N- to NH_4 ,suggested that the excess of organic nitrogen not required by microbes was released as ammonia which got dissolved in water and increased the pH of the vermicompost. Sharma,(1986).also reported an increase in pH during vermicomposting of solid waste and beverage biosludge. Swaby, 1949) asserted that an increase in pH during composting and vermicomposting process was due to progressive utilization of organic acids and an increase in mineral constituents of the waste.

The reports regarding electrical conductivity during vermicomposting process are contradictory, some workers reported decrease in electrical conductivity and others an increase in electrical conductivity (Hait and Tare, 2011). The decrease has been attributed to a decrease in ions after forming a complex whereas the increase has been attributed to the degradation of organic matter to release cations and release of different mineral salts in available forms such as phosphate, ammonium and potassium (Paavilainen, 1993a).

Nitrogen

Nitrogen generally declines during traditional composting due to use of nitrogen by the rapidly multiplying heterotrophic bacteria but it increases during vermicomposting (Singh, 1987).Sosamma (1998) attributed the decrease in nitrogen and potassium content during the vermicomposting of kitchen waste by Pe. excavatus. This is probably due to NH3 volatilization, incorporation into earthworm tissue and leaching into bedding material with as well as without earthworms or due to release of ammonia (Guest et al., 2001). Although, nitrogen content increased during the process of vermicomposting of various materials but final TKN content in vermicompost was always dependent on the initial nitrogen present in the feed material and the degree of decomposition (Suthur, 2008). According to Reddy,(1988), losses in organic carbon might be responsiblefor nitrogen addition along with it mucoproteins in the mucus secreted by epidermal glands, urea excreted through nephridia and ammonia through the gut with cast materials helped in enhancing the nitrogen in the vermicompost. Decaying tissue of dead worms also adds a significant amount of nitrogen to the vermicomposting system. Ei.foetida also produce favorable condition for nitrification of cow slurry. The worm excreta convert it into the mineral form as ammonium in muco proteins and the ammonium in the soil get further converted into nitrates (Hand et al., 1988).

Earthworms may influence microbial N transformation such as mineralization, nitrification and denitrification through their interaction with soil biota and increase concentration of ammonia in the freshvermicasts, the found that much of the 15Nitrogen released from decomposing earthworm tissue was cycled through microbial biomass within four days and 70% of 15Nitrogen from decomposing earthworm accumulated in plant shoot biomass after 16 days. Amador et al. (2003) estimated that the organic nitrogen released by dead earthworms reached to 21.1-38.6 t / h / year. While Kumar et al. (2010) revealed that the nitrogen content decreased during vermicomposting which may have been due to ammonification, NH3 volatilization and denitrification. The decrease in nitrogen was also supported by Anantharam and Balagur, (2008) who observed a 36% loss of total nitrogen during vermicomposting of sewage sludge.

Organic carbon and C: N ratio

Earthworms modify the soil through their feeding, casting, and burrowing activities, which may lead to more decomposition and respiration in aerobic microsites and more denitrification in anaerobic microsites. A decline in C: N ratio to less than 20 indicates an advanced degree of organic matter stabilization and reflects a satisfactory degree of maturity of organic wastes (Munnoli, 1998). Earthworms also increase CO2 and N2O fluxes from unfertilized agro-ecosystems. Munnoli, (2007) observed that mean CO2 and N2O fluxes during the study period tended to be greater from enclosures with added earthworms than the control (no earthworms added), but were non significantly different due to the low survival rate of introduced earthworms. Better control of earthworm populations in the field is required to fully assess the impact of earthworms on CO2 and N2O fluxes from temperate agro-ecosystems. Munnoli, et al.(2000) also found that the rate of CO2 production from vermicompost piles wasmuch higher than that of traditional compost. During vermicomposting period faster decline in C: N ratio (from 17.92 to 10.15%) as compared to compost without earthworm was also observed by Cabrera et al. (2005). However, Atiyehet al., (2002) reported that the C: N ratio of the manure with or without earthworms decreased progressively from 36 to 21.

Phosphorus

Phosphorus is an important nutrient for plants and is used for seed germination, photosynthesis, protein formation, overall growth and metabolism, flower and fruit formation. However, a large fraction of soil phosphorus is in mineral form and not readily available for plants but the potential activity of phosphate solubilizing microorganisms and earthworm increases phosphorous availability for plants (Kumar and Singh, 2001). Edwards,(1996), asserted that the rise in total phosphorous during vermicomposting was probably due to mineralization and mobilization of phosphorus as a result of bacterial and faecal phosphatase activity of earthworms. In 1999, Patron et al. noted that earthworm activity accelerated transformation of organic phosphorous to plant available phosphorus form. An increase of up to 25% in total phosphorus of paper waste sludge was noted by Gupta and Garg, (2009), found 12-20.9% increment in the amount of easily extractable phosphorus during vermicomposting of different waste materials, hinting towards the efficiency of earthworm in increasing availability of phosphorus and decreasing the magnitude of fixation of released phosphorus into insoluble inorganic forms (Iyer- et al., 2012).

Potassium

There are contradictory reports regarding the total potassium content in vermicomposts obtained from different substrates due to the differences in the chemical nature of the initial raw materials (Kaviraj and Sharma,2003). Kutschera and Elliott, (2010) have reported that the leachates collected during vermicomposting process had higher potassium concentrations. The decrease in total potassium of vermicompost after bioconversion of paper pulp mill sludge and sugar mill sludge by Ei.andrei was attributed to leaching by Manimozhiet.al., (2006).

HeavyMetals

Heavy metals released into environment, from waste, pose a serious problem. It accumulates in living organisms and circulates in the trophic chain and moreover its dangerous concentrations persist in ecosystems for a long time (Muthukumaravelet.al.,2008). All types of municipal solid waste (MSW) contain more heavy metals than the background concentrations present in soil and will increase their contents in amended soil (Smith, 2009). He found that Zn and Pb are numerically the elements present in the largest amounts in MSW. The most important pollutants listed in Lee (1985) are Pb, Cd, Hg, Zn, Cu, Ni, Sb, Bi. The literature information also shows that cadmium is the most absorbed among 8 heavy metals and that it is easily transferrable (Muthukumaravelet.al.,2008).Several works have been done to remediate heavy metals from waste through vermicomposting. Remediation of heavy metals from the sewage sludge amended with sugarcane trash was done using pilot-scale (PS) vermicomposting operation (Kumar and Singh, 2001), who reported that vermicomposting caused significant reduction in total concentration of metals: Zn (15.1–39.6%), Fe (5.2–29.8%), Mn (2.6–36.5%) and Cu (8.6–39.6%) in sludge. The use of vermicompost as adsorbent substrate for removing Pb, Ni, V and Cr from waste waters was proposedby (Kaviraj and Sharma,2003). (Munnoli, 1998)classified(MSW)flyashasahazardous material because it contains high amounts of heavy metals which can be removed from municipal solid waste fly ash by chlorination and thermal treatment. Mohan and Gandhimathi (2009) used ash as an effective low cost adsorbent for the removal of heavy metal ions from municipal solid waste leachate.(Lukkari et al., 2004) found that diversity, total numbers and biomass of earthworms increased with increasing distance from the emission sources of industries. A positive correlations between metal concentrations in the earthworms and those in the soils were observed with differences in bioaccumulation factors for different metals, this could be due to a variable metabolic requirement of earthworms of metals. (Zhang et al., 2009) reported that Bioaccumulation factors of methyl mercury from soil to earthworms were much higher than those of total mercury, which suggested that methyl mercury might be more easily absorbed by and accumulated in earthworms because of its lipid solubility. (Frank et al., 1983) noted slight increase in the metal contents in worm castings except for Cr and Zn over the worm feed mixture. This could be explained by the fact that organic matter was being reduced on passage through the gut of worms but actually worms did not appear to bioaccumulate metals within their tissue. Hait and Tare,(2011)reported an increase in heavy metal content in the vermicompost of paper mill sludge. The increase was more appreciable for Fe and Cu. The weight and volume reduction due to breakdown of organic matter during vermicomposting might have been the reason for increase in heavy metal concentrations in vermicompost. A 2% increase in Cu and a decline in the concentration of Mn, Zn and Pb in vermicompost were reported by Hand et al.,(1988).

II. CONCLUSION

A fundamental change in attitude is needed in the way wastes are managed. As the population keeps growing, more pressure is put on waste disposal of different kinds.In future, need for clean and safe environment will be among the most seriousproblems that need to be tackled. Preserving the environment is a major challenge that India and world over is facing today. It is necessary for the environmentalists and women, to save the environment for better tomorrow for the next generation.Sensitization and mass awareness can contribute towards proper and safe disposal of waste

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