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Review Article

A REVIEW ON BACTERIAL ENRICHED VERMICOMPOST AND ITS APPLICATIONS

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ABSTRACT

Generation of the massive quantity of solid waste around the globe is a major ecological and technical problem. Vermicomposting may be the viable option to handle solid waste in an environmentally friendly way. Vermicompost have higher level of available nutrients like carbon, nitrogen, phosphorous and potassium, calcium and magnesium which are derived from the wastes. Many researchers have attempted to evaluate for development of efficiency vermicompost by using varieties of earthworms. The use of earthworms in the degradation of different types of wastes is continuing from the past so many years. These wastes include industrial, agricultural of plant debris and domestic waste papers and cattle dung. Fixed nitrogen is a limiting nutrient in most environments, with the main reserve of nitrogen in the biosphere being molecular nitrogen from the atmosphere. Molecular nitrogen cannot be directly assimilated by plants, but it becomes obtainable through the biological nitrogen fixation process that only prokaryotic cells have developed. Vermicompost is an effective carrier for bacterial growth so that the symbiotic bacterial species such *as Mycorrhiza* and *Dyaztotor* of helps in the rapid growth of plant while *Azotobactor, Rhizobium* involves in the fixation and storing of nitrogen for plants. This review focus on the vermicomposting and microbial enrichment of vermicompost for the exceed crop production.

Keywords: Vermicompost, Earthworm, Nitrogen fixing bacteria, Enrichment, Plant growth.

INTRODUCTION

Vermicompost is the products of the Plants and By-products degradation of organic matter through interactions between earthworms and microorganisms. Vermicomposts are finely resolved as peat-like materials with high porosity, aeration, drainage, and water-holding capacity and usually contain most nutrients in the available forms such as nitrates, phosphates, exchangeable calcium and soluble potassium (Edward *et al*., 1998). Free-living nitrogen fixing bacteria such as; *Azotobacter chroococcum* and *Azospirillum lipoferum*, were found to have not only the ability to fix nitrogen but also the ability to release phytohormones similar to gibberellic acid and indole acetic acid, which could stimulate plant growth, incorporation of nutrients, and photosynthesis. Vermicomposting is the effective technology of waste management (Mohammad Taghi Darzi *et al*., 2015). In many studies, it was reported that the waste placed in landfill or in open dumps caused groundwater contamination due to leach ate of organic and inorganic compounds present in waste. Landfill dumping also promotes the greenhouse effect too. Similarly, incineration treatment is restricted because of its low-fattening value and the cost of fuel increments. In the case of sewage sludge, it is directly disposed off on agricultural lands because of its high nitrogen (N) and phosphorus (P) contents used as fertilizer; however, it may cause toxicity for soil and plants and have depressive effects on the metabolism of soil microorganisms. Under these conditions, vermicomposting may be a viable technology that is ecologically sound, and it not only becomes eco-friendly but also economical for converting solid wastes into organic rich manure (Ushmanali *et al*., 2015).

Vermicomposting

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 product. Vermicomposting differs from

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composting in several ways. It is a mesophilic process that utilizes microorganisms. The process is faster than composting; because the material passes through the earthworm gut, a significant but not fully understood transformation takes place, whereby the resulting earthworm castings (worm manure) are rich in microbial activity and plant growth regulators, and equipped with pest repellence attributes as well. In short, earthworms through a type of biological alchemy are capable of transforming garbage into "gold" (Sujit Adhikary *et al*., 2012). The mixture of substrate and co-substrate changes the physicochemical nature of the waste, which could ultimately affect the vermicomposting process. These organic substrates provide such chemical nature to the waste which increases the efficiency of worms in vermicomposting system by increased rate of waste reduction. It also provides fertilizer worth of the vermicomposting, growth, and reproduction of the worms during the vermicomposting process (Manohar A.L and Tulasi T *et al*., 2016).

Vermicompost nutrients

Vermicompost is an excellent soil stabilizer made up of digested compost. Worm castings are much higher in nutrients and microbial life and therefore, are considered as a higher value product. Worm castings contain up to 5 times the plant available nutrients found in average potting soil mixes (Manohar A L and Tulasi T *et al*., 2016).Chemical analysis of the castings was conducted and found that it contains 5 times the available nitrogen, 7 times the accessible potash and 1.5 times more calcium than that found in 15 cm of good top soil. In addition, the nutrient life is up to 6 times more in comparison to the other types of potting mixes. It is reported that phosphorous while passage through gut of worms is converted to the plant available form. Phosphorous is generally considered as a limiting element for plant growth. Therefore, any process that drastically increases phosphorous availability through plants and organic matter will be very essential for agriculture. (Sujit Adhikary *et al*., 2012).

Nitrogen fixing bacteria

Biological nitrogen fixation is one way of converting elemental nitrogen into plant usable form. Nitrogen-fixing bacteria (NFB) that purpose to transform inert atmospheric N_2 to organic compounds (Gothwal R.K *et al*., 2007). Nitrogen fixer or N fixers organism are used in biofertilizer as a living fertilizer composed of microbial inoculants or groups of microorganisms which are able to fix atmospheric nitrogen (Bakulin MK *et al.*,2007). They are grouped into free living bacteria (*Azotobacter* and *Azospirillium)* and the blue green algae and symbionts such *as Rhizobium, Frankiaand Azolla*. The list of N2 - fixing bacteria associated with nonlegumes includes species of *Achromobacter, Alcaligenes, Arthrobacter, Acetobacter, Azomonas, Beijerinckia, Bacillus, Clostridium, Enterobacter, Erwinia, Derxia, Desulfovibrio, Corynebacterium, campylobacter, Herbaspirillum, Klebsiella, Lignobacter, Mycobacterium, Rhodospirillum, Rhodopseudomonas, Xanthobacter, Mycobacterium* and *Methylosinus* (Gupta A K *et al*., 2004). Although many genera and species of N2 -fixing bacteria are isolated from the rhizosphere of a variety of cereals, principally members of *Azotobacter* and *Azospirillum* genera have been widely tested to increase yield of cereals and legumes under field condition (Wani S.P *et al.*, 1990).

Nitrogen fixing biofertilizer Rhizobium

This group belongs to family *Rhizobiaceae*, symbiotic in nature, fix nitrogen 50-100 kg/ ha with legumes only. It colonizes the roots of specific legumes to form tumour like growths called root nodules, which acts as factories of ammonia production. *Rhizobium* has ability to fix atmospheric nitrogen in symbiotic association with legumes and certain non-legumes like Parasponia. Based on cross-inoculation studies, six species of *Rhizobium* are defined according to the legume host(s) which theynodulate. A cross-inoculation group refers to a collection of leguminous species that develop nodules on any member of that particular plant group. Therefore, a single cross inoculation group ideally includes almost all host species which are infected by an individual bacterial strain (Claudine *et al*., 2009).

Table 1. Species of *Rhizobium* and cross inoculation groups of host plants (Claudine *et al*., 2009).

Rhizobium sp.	Host genera	Cross inoculation
R. japonicum	Glycine	Soybean group
R. leguminosarum	Pisum, Lathyrus, Vicia,Lens	Pea group
R. lupini	Lupinus, Ornithopus	Lupin group

Azospirillum

This belongs to the family *Spirilaceae*, heterotrophic and which are associative in nature. In addition to their nitrogen fixing ability of about 20-40 kg/ ha, they also produce growth regulating substances. Although there are many species under this genus like, *A. amazonense, A. halopraeferens, A. brasilense*, but, worldwide distribution and benefits of inoculation have been proved mainly with the *A. lipoferum* and *A. brasilense*. This genus goes under the C4-dicarboxyliac path way of photosynthesis (Hatch and Slack pathway), because they grow and fix nitrogen on salts of organic acids such as malic acid, aspartic acid. Thus

it is mainly suggested for maize, sugarcane, sorghum, pearl millet etc (Shamsul haq *et al*., 2015).

Azotobacter

This microorganisms belongs to family *Azotobacteriaceae*, aerobic, free living and heterotrophic in nature. Azotobacters are present in neutral or alkaline soils and *A. chroococcum* is the most commonly occurring species in arable soils. The bacterium produces anti-fungal antibiotics which inhibits the growth of several pathogenic fungi in the root region thereby preventing seedling mortality to a definite extent. The incidence of this organism has been reported from the rhizosphere of a number of crop plants such as rice, maize etc. (Shamsul haq *et al*., 2015).

Role of Vermicompost

Beneficial roles of vermicompost red worm castings contain a high percentage of humus. Humus helps soil particles form into clusters, which create channels for the passage of air and improve its capacity to hold water (Sujit Adhikary *et al*., 2012). Humus is believed to aid in the prevention of harmful plant pathogens, fungi, nematodes and bacteria. A worm casting (also known as worm cast or vermicast) is a biologically active mound containing thousands of bacteria, enzymes, and residues of plant materials that were not digested by the worms. Castings contain nutrients that are readily available to plants. The activity of the worm gut is like a miniature composting tube that mixes conditions and inoculates the residues. Vermicompost has higher nutritional value than traditional composts. This is due to increased rate of mineralization and degree of humification by the action of earthworms. Vermicompost has high porosity, aeration, drainage, and water-holding capacity. Presence of microbiota particularly fungi, bacteria and *actinomycetes* makes it suitable for plant growth. Nutrients such as nitrates, phosphates and exchangeable calcium and soluble potassium in plant-available forms are present in vermicompost. Plant growth regulators and other plant growth influencing materials produced by microorganisms are also present in vermicompost (Margit olle, 2019).

Effect of vermicompost on agricultural crop performance

Yield Studies on the production of important vegetable crops like tomato *(Lycopersicon esculentum*), eggplant (*Solanum melongena*) have yielded very good results. Similarly the overall productivity of potato was significantly higher on vermicompost applied about 6 tons/ha as compared to control. Vermicast produced higher garden pea green pod plants, higher green grain weight per plant, and higher green pod yield as compared to chemical fertilizer (Adhikary, 2012). The perusal of the data revealed that "Parthenium Vermicompost" applied at 5 t/ha enhanced the yield of eggplants (*Solanum melongena*). The use of vermicompost as a source of organic manure in supplementing chemical fertilizer is becoming popular among the farmers of the country. Vermicompost increase in crop yield probably because of higher nutrient uptake (Seethalakshmi *et al*., 2011).

Effects of enriched vermicompost

Analysis of variance for effects of different enriched vermicompost treatments on some Morpho/ Physicological attributes the plant growth. The effects of most of the treatments were significant. The treatments of Nitrogen bio- fertilizer addition, compost type, and compost rate all significantly influence the plant growth. Inoculated compost was clearly superior to noninoculated compost in promoting plant growth. Since the process of vermicomposting increases microbial diversity and activity significantly, it is possible that vermicomposts could be a definitive source of plant growth regulators produced by interactions between microorganisms and earthworms, which could contribute significantly to enhancement of plant growth (Arash hemati *et al*., 2016).

CONCLUSION

Vermicompost produced by the activity of earthworms is rich in macro and micronutrients, vitamins, growth hormones, enzymes such as proteases, amylases, lipase, cellulose and chitinase and immobilized microflora. Vermicompost is optimal organic manure for better growth and yield of many plants. Nitrogenous biofertilizer help in increasing crop productivity by way of increased BNF, increased availability or uptake of nutrients or increased absorption and stimulation of plant growth through hormonal action or antibiosis, or by decomposition of organic residues. Furthermore, nitrogenous biofertilizers as to replace part of the use of chemical N-fertilizers reduces amount and cost of chemical N-fertilizers and thus prevents the environment pollution from extensive application of these fertilizers**.**

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