Minireview Article

A Review on Vermicompost Enrichment: in prospect of village level

Abstract

Cow dung is very useful as fertilizer, with help of earthworms a unique product vermicompost is formed. Importance of vermicompost over chemical fertilizer is accepted by all. There is plenty of cow dung but vermi tank are limited, here we have discussed some innovations to fasten the process of maturation by using decomposer, bacteria and fungi species, here we have reviewed different methods. It found significantly higher phosphorus percent in slurry method, slight more K percent compare to conventional method, not much difference in N content are reported , almost two folds increase in useful bacteria fungi and azotobacter population are recorded as compare to conventional. There are reported increase in N and P contents of manure after inoculation of phosphate solubilizing bacteria (PSB) and N-fixing bacteria. Waste decomposer which contains fungi *Trichoderma viridae* and strains of bacteria *Pseudomonus fluorescence* and *Azotobactor chroococcum* also impart positive effects on nutrients composition in manure and also a symbiosis effect on earthworm population . The method of Pile composting enriched with decomposer will be prove as very useful for huge quantity waste with less resources and time.

Keywords: Vermicompost, Vermi tank, Earthworm, Nitrogen, Phosphorus, Potassium.

Introduction

World population are rising, it has resulted increase of organic waste production from Animal husbandry, households, and agriculture . (Prasad et al., 2014). Scraping of these wastes in open creates serious environmental issues.(Parihar et al., 2019) . By recycling and converting these wastes into nutrient enrich fertilizer so it become valuable organic resource with almost zero input (Kholia and poudel, 2021). People are now much aware about toxic effects of chemical fertilizers (Chandini et al 2019), as well as farmer can easily take up organic vermi compost over chemicals due to good result and much demand of organic products (Yangchan et al., 2019). Organic farming also enhances ecological conservation due to less pollution to environment (Das et al., 2020) . chemical fertilizers can be easily replaced by vermi compost (Thakur et al., 2021). As it is more rich in NPK, and ashes and beneficial soil microorganism (nitrogen fixing and phosphate solubilizing bacteria and actinomycetes), as compare to normal compost, vermi compost is excellent growth promoter and protector for crop plants (Bhatta et al., 2021).

On the auspicious day of *Hareli a* scheme Godhan Nyay Yojna have been launched by Chhattisgarh Government, this scheme fetches new hope for farmers, they can sell cow dung. The scheme involves collection of cow dung by the *Gauthan* Committee and SHG in each village. payment is done by DBT method in bank account at rate of 2 rupees per kg. Many vermitanks of a capacity of 1,000 kg are being made in all the *Gauthan*s. vermicompost can be generated in approximately 60-70 days (Masullo, 2017). With this, farmers, who currently buying chemical fertilizers that are highly priced are expected to make the use of organic fertilizer (Altuntas , 2018, Kashem et al., 2015). In this article we will review about vermicomposting, how we can enhance quality and fasten the process.

Vermicomposting is a mesophilic process which includes a mutual action of earthworms and mesophilic microbes for the transformation of organic wastes into a valuable end product known as vermicompost (Bhat et al., 2017)

Vermicompost has: -

- Higher N availability, C, P, K, Ca and Mg plant nutrients availability in the earthworm casts are also found.
- High porosity, aeration, and water-holding ability
- Plant growth hormones auxins and cytokinin's are found.
- Earthworms increase the mineralization rate and convert the manures into casts with higher degree of humification (Karmakar, 2015)

Table1:Composition of nutrients in vermicompost is as follows: (Nagavallemma, *et al.*,2004).

Organic carbon	9.5–17.98%	Calcium	1.18 -7.61%
Nitrogen	0.5–1.50%	Copper	2–9.50 mg/kg
Phosphorous	0.1–0.30%	Iron	2–9.30 mg/kg

Potassium	0.15–0.56%	Zinc	5.70–11.50 mg/kg
Sodium	0.06–0.30%	Sulfur	128–548 mg/kg
Magnesium	0.093-0.568%	C:N	15.5

Level of Plant Hormone in Vermicompost (Zhang et al., 201)

	Phyto hormone	**Absolute Conc. ng/gm**
1	**tZ (trans-zeatin)**	**0.03**
2	**iP (isopentyl adenine)**	**0.49**
3	**iPR (isopentyl adenosine)**	**0.53**
4	**IAA (indole acetic acid)**	**79.78**

Vermicomposting

Earthworms encourage the growth of “beneficial decomposer aerobic bacteria, Earthworm hosts millions of microbes (Nagavallemma et al., 2004) hydrolytic enzymes protease, amylase, lipase, cellulose and chitinase and hormones that helps in rapid decaying of complex organic matter into vermicompost in a relatively smaller duration of 2 months (Maji et al., 2017) There are water passing through columns of vermi beds ,which percolates from vermibed, it called Vermiwash a liquid fertilizer rich in plant growth hormone are used as a foliar spray (Gudeta et al., 2021).

Suitable environmental conditions for earthworms

Optimum temperature 15–25°C, Moisture content 75–90%, low Ammonia content of the waste: <1 mg, low Salt content < 0.5% and pH of 5–9 are suggested for earthworm. (Hashemimajd et al., 2006)

Vermicomposting methods

1. Bin composting: one of the most common method used for small level composting. The bin can be made up of different materials like plastic/recycled container. A bin can be in various size, its average size should be 45 × 30 × 45 cm. there should be holes at all around the bin for proper aeration and drainage. (Nasiru, 2013)

2. Pit composting: This method is used for large scale production. pit should be 2.5 m × 1 m × 0.3 m of size. There must be an pen sided and a shed like structure to provide aeration and preventing direct sunlight and rain. (Adhikary, 2012)
3. Pile composting: This method is used for larger scale production. The piles can be made in any place under green house. its average height should be 40 cm. this process is very useful if gauthan having plenty of cowdung and no place in vermi tank. It can be made in any length and width (Lim et al., 2015)

1. **Required Materials:** Nitrogen and Carbon-rich organic wastes, gunny bag spade, water sprinklers, net and earthworms.

2. **Site Selection:** Vermicompost production should be done at a place which is having shades, cool and has high humidity. (Khalid et al., 2011)

3. **Shredding of organic waste material:** glass and metals should be separated from organic wastes

4. **Pre-digestion of organic waste material:** Cow dung should be taken place at least 15-20 days old to avoid heat generation during the vermi composting. (Pathma and Sakthivel, 2012)

1. **Conventional method**

In this method a layer of broken bricks (3-4 cm) are used to fill the tank to drainage of excess water (Phukan et al., 2007). Bed for the earthworms is formed by a 3 cm layer of a mixture of dried cow dung and sieved garden soil in the ratio of 1:1. Then half decomposed cow dung and chopped rice straw are filled in the tank in alternate layers of 6 cm thickness. Earthworms of 2kg weight are introduced in tank. Cover the upper layer with gunny bags and maintain the moisture. The matured VC is removed from the tank after 60 days (Ali et al., 2018) C:N ratio is declined during vermicomposting process (Suther, 2008). CN ratio act as an index of vermicompost maturity, (Bernal et al., 2009). C:N ratio should be below to 20.

2. **Slurry method (non-enriched)**

Cow dung slurry is prepared in a cemented tank by mixing cow dung to water in a 3:5 ratio. The partially decomposed waste grass paddy straw can be added to the slurry. 2 kg of (approx. 2000) earthworms are added after 5-7 days. After 50- 55 days it converted into vermicompost Found CN ratio 18, significantly higher phosphorus percent in slurry method, slight more K percent compare to conventional method (Suthar, 2010)., not much difference in N content are reported (Rajshekhar and Ravichandran, 2015). almost two-fold increase in bacteria fungi and azotobacter population are recorded as compare to conventional (Yadav and Garg, 2016). More numbers of azosprilium and Actinomycetes recorded compare to former method (Phukan et al., 2013).

3. Slurry method (Phosphate and microbial enriched vermicompost)

In this method during the preparation of slurry of cow dungnd biowaste, rock phosphate (RP) was also mixed (5% of the total weight) . after 5-7 days, inoculation of 2 kg of earthworms. After 50- 55 day of decomposer like phosphate solubilizing bacteria (PSB), N-fixing bacteria viz., *azospirilum and azotobacter* (1kg each/100 kg vermicompost) were introduced to the VC and kept undisturbed for 15-20 days. The enriched VC maintained lowest C:N ratio (14) among other methods of composting. Enrichment by RP followed by N-fixing bacteria addition hasten the N accumulation in the VC and presence of PSB that provided sufficient phosphate for growth of N-fixing bacteria. phosphate conserves the N by reducing the number of denitrifying bacteria and enhancing the growth of N-fixing bacteria (Satisha and Devarajan , 2007) (Phukan et al., 2013).

In enriched VC maximum values of total N, total P_2O_5 and total K_2O contents are reported. (Kaushik and Garg, 2004) (Karmegam and Rajasekar, 2012) recorded that addition of N-fixing bacteria significantly higher N content in vermicompost (Parastesh et al., 2020). The results also showed that the vermicompost enriched with RP with inoculation of beneficial bacteria exhibit higher total and available P_2O_5 as compared to others. (Biswas and Narayanaswamy, 2006) (Hussain et al., 2017). Humification indices are good indicator of the compost maturity (Saviozzi et al., 1988). high HA percentage means good compost ability. microbial and rock phosphate enriched vermicompost resulted higher microbial population (Rajasekar et al., 2012).

4.Vermicompost enriched with bacteria and fungi (Waste Decomposer)

There are various fungi and bacterial strains which actively use as waste decomposer to fasten the rate decomposition, these found effective in vermicomposting process to reduce the time. Strains of fungi namely *Trichoderma viridae* and strains of bacteria namely, *Pseudomonus fluorescence* and *Azotobactor chroococcum* either singly or in different combination are mixed well. A preliminary fermentation with *Trichoderma* is good, since this allows the vermicultivation time to be reduced and the yield and quality of vermicompost to be enhanced. *P. fluorescence* had most significant positive effect on earthworm population and dry weight immediately followed by *A. chroococcum* and fungal *T. viridae* showed positive effect on earthworm population and dry weight;Significantly higher total fungal population and Higher total bacterial population was recorded in treatmentFurther, increased earthworm population in presence of bacteria can also be due to the fact that bacteria are important source of nutrients (Tiunov and Scheu, 2004) and protein for earthworm (Wright, 1972). The higher fungal population explained by the availability of nutrient rich organic waste and increase surface area of ingested waste by mechanical action of earthworm by Karmegam and Daniel (2009), Prakash et al., (2009). The increase in bacterial count and growth reported due to ingestion of *Pseudomonus fluorescence* and *Azotobactor chroococcum* along with organic wastes by earthworms. inside gut of earthworm, it provides suitable environment and substrate to feed for microbial organisms.

Conclusion

Chemical fertilizers are formulated from "vanishing resources" of earth and crops cultivated on chemical fertilizers have contaminated and low nutrient value in comparison to grown organic way. Organic Farming' has to be promoted to protect human health from the harmful chemical and maintain the agro-ecosystem. Organic farming with use of vermicompost and its enrichment could substitute the chemical fertilizers and can reduce the economic cost and may also lead to organic products which fetches higher price in the market.

References: -

Adhikary, S., (2012) Vermicompost the story of a organic gold: A review. *Agricultural sciences* **3.** 24396.

Ali, R.R., Jafrapour, M. K. and Pessarkli , M.M., (2017) Effects of raw materials on vermi compost qualities. *Journal of plant nutrition*. **40** (11):1635-1643.

Altuntas, O., (2018) A comparative study on the effects of different conventional, organic and bio-fertilizers on broccoli yield and quality. *Applied Ecology and Environmental Research*. **16.** 1595-1608.

Bernal, M. P., Alburquerque, J. A. and Moral, R., (2009) Composting of animal manures and chemical criteria for compost maturity assessment: A review. *Bioresour. Tech.*,**100**: 544-553.

Bhat, S.A., Singh, J. and Vig, A.P., (2017) Earth worm as organic waste managers and biofertilizer producers. *Waste and biomass Valorization*. **9**:1073-86.

Bhatta, K., Baral, B., Nayak, S. S., Das, S., (2021) Efficacy of Vermicompost in Agriculture- A review. *Int. Journ. of Botany Studies*. **6** (4): 532-535

Biswas, D. R. and Narayanasamy, G., (2006) Rock Phosphate Enriched Compost: An Approach to Improve Low Grade Indian Rock Phosphate. *Bioresour. Tech.,* **97**: 2243-2251.

Chandini , Kumar, R., Kumar, R. and Prakash, O.,(2019) The Impact of Chemical Fertilizers on our Environment and Ecosystem. https://www.researchgate.net/publication/331132826

Das,S., Chatterjee, A., Pal, T.K. (2020) Organic farming in India: a vision towards a healthy nation, *Food Quality and Safety*, **4**: (2) 69–76, https://doi.org/10.1093/fqsafe/fyaa018

Gudeta, K., Julka, J., & Kumar, A., Bhagat, A., and Kumari, A., (2021) Vermiwash: An agent of disease and pest control in soil, a review. *Heliyon*. **7**. 10.1016/j.heliyon.2021.e06434.

Hashemimajd, K., Kalbasi, M., Golchin, A. and Sharitamadari, H., (2006) Comparison of vermicompost and composts as potting media for growth of tomatoes. *Journ. of Plant nutrition*. **6**:1107-1123.

Hussain, S., Jahangeer A., Zubair, M., Ruhul, N. and Misger, F., (2017) Quality evaluation of chemically-enriched compost, vermicompost and conventional compost. *An Asian Journal of Soil Science*. **12** (1): 66-70.

Karmakar, S., Adhikary, M., Gangopadhyay, A., and Brahmchari, K., (2015) Impact of vermicomposting in agriculture waste management vis-à-vis soil health care. *Journal of environmental science and natural resources* **8**:1.

Karmegam, N. and Daniel, T., (2009) Investigating efficiency of Lampitomauritii (Kinberg) and *Perionyxceylanensis* for vermicomposting of different types of organic substrates. *Environmentalist*. **29**: 287-300.

Karmegam, N. and Rajasekar, K., (2012) Enrichment of Biogas Slurry Vermicompost with *Azotobacter chroococcum* and *Bacillus megaterium*. *Journal of Environmental Science and Technology*, ***5**: 91-108.*

Kashem, M., Sarker, A., Hossain, M., Imam and Islam, M., (2015) Comparison of the Effect of Vermicompost and Inorganic Fertilizers on Vegetative Growth and Fruit Production of Tomato (*Solanum lycopersicum* L.). *Open Journal of Soil Science*. **5**. 53-58.

Kaushik, P. and Garg, V.K., (2004) Dynamics of biological and chemical parameters during vermicomposting of solid textile mill sludges mixed with cow dung and agricultural residues. *J. of Bioresource Technology*, **4**: 203-209.

Khalid, A., Arshad, M., Anjum, M., Mahmood, T., and Dawson, L., (2011) The anaerobic digestion of solid organic waste. *Waste management*. **31**(8):1737-1744.

Kholia, D. and Poudel G., (2021) To Find the Rapid Method of Vermicomposting. *AIJR Preprints,* **342**, 1, DOI: https://doi.org/10.21467/preprints.342.

Lim, S.L., Wu, T.Y., Lim, P.N. and Shak, K., (2015) The use of vermi compost in organic farming: overview effects on soil and economics. *Journal of science food and agriculture*.**95**(6):1143-5.

Maji D., Mishra, P., Singh. S., Kalra, A., (2017) Humic acid rich vermicompost promotes plant growth by improving microbial community structure of soil as well as root nodulation and mycorrhizal colonization in the root of pisum sativam, *Applied social Ecology*.**110**:97-108.

Masullo, A., (2017) Organic wastes management in a circular economy approach: rebuilding the link between urban and rural areas, *Ecological Engineering*. **101**:84-90.

Nagavallemma, K.P., Wani, S.P.,,Stephane L., Padmaja V.V., Vineela C.,Babu Rao, M., (2004). Vermicomposting: Recycling wastes into valuable organic fertilizer. Global Theme on Agr . ecosystems [Report]. Patancheru, Andhra Pradesh: International Crops Research Institute for the Semi-Arid Tropics; 2004.

Nasiru, A., Ismail, N. and Ibrahim, N., (2013) Vermicomposting: tools for sustainable ruminant manure management. *Journal of waste management* **2013:**732759.

Parastesh, F., Alikhani, H., & Etesami, H., (2019). Vermicompost enriched with phosphate-solubilizing bacteria provides plant with enough phosphorus in a sequential cropping under calcareous soil conditions. *Journal of Cleaner Production*. 221. 10.1016/j.jclepro.2019.02.234.

Parihar, S.S., Saini, K.P.S., Lakhani, G.P. Jain, A. Roy, B., Ghosh,S. and Aharwal.B., (2019) Livestock waste management: A review. *J Entomol Zool Stud* **7**(3):384-393.

Pathma, J. and Sakthivel, N. (2012) Microbial diversity of vermicompost bacteria that exhibit useful agricultural and waste management potential. *Springerplus* **26** .

Phukan, I., Bhagat, R.M. and Saffique, S. (2007). Conversion of biowaste into vermicompost. I. Suitability of earthworm. *Two & Bud.* **54**. *34-41.*

Phukan, I. & Khanikar, L., Ahmed, C., Saffique, S., Jahan, A., Baruah, A., and Phukan, I., (2013). A novel method for improving the quality of vermicompost. Two & a Bud**. 60**. 24-29(

Prakash, M., Jayakumar, M. and Karmegam, N., (2009). Vermistabilization of paper mill sludge using the earthworm *Perionyxceylanensis*: influence on physico-chemical and microbiological status, *Indian J. Appl. Microbiol*. **10**:20-25.

Prasad, C.S., Prasad, G., Singh, R., Sharma, R.P., Kumar A.T., Pradhan S., (2014) Handbook of animal huabandry, 4th Edn., Indian council of agricultural research New Delhi, 41-56.

Rajasekar,K., Daniel, T., and Karmegam, N., (2012). Microbial Enrichment of Vermicompost. ISRN *Soil Science*. **2012:** 1-13.

Rajeshkumar, K. T. and Ravichandran, C., (2015) Vermicomposting of biogas plant slurry and cow dung with Eudrilus eugeniae and its effects on Vigna radiata . *Advances in Applied Science Research***, 6** (7):159-164.

Satisha, G. C. and Devarajan, L., (2007). Effect of amendments on windrow composting of sugar industry press mud. *Wast. Manag.* **27:** 1083-1091.

Saviozzi, A., Levi-Minzi, R. and Riffaldi, R. (1988). Maturity evaluation of organic waste. Bicycle **29** (3): 113-22.

Suthar, S. (2008). Bioconversion of post harvest crop residues and cattle shed manure into value added products using earthworm Eudrilus eugeniae. *Ecological Engineering*, **32:**206-214.

Suthar, S. (2010). Potential of domestic biogas digester slurry in vermitechnology. *Bioresource technology*, **101**(14), 5419–5425. https://doi.org/10.1016/j.biortech.2010.02.029

Thakur, A., Kumar, A., Kumar, C.V., Kiran, B.S., Kumar S. and Athokpam, V. (2021) A Review on *Vermicomposting : By-Products and its Importance*. Plant Cell Biotechnology and Molecular Biology **22**(11&12):156-164; ISSN: 0972-2025

Tiunov, A.V and Scheu, S. (2004) Carbon availability controls the growth of detritivorous (Lumbricidae) and their effect on N mineralisation. *Oecologia*, **138** (1), 83-90.

Wright, M.A. 1972. Factors governing ingestion by the earthworm *Lumbricus terrestris* with special reference to apple leaves. *Ann.Biol*.**70:** 175-188

Yadav, A., Garg, V.K.(2016) Vermiconversion of biogas plant slurry and parthenium weed mixture to manure. *Int J Recycl Org Waste Agricult* **5,** 301–309 (2016). https://doi.org/10.1007/s40093-016-0140-8

Yangchan, J., Ganie, SA., Wani, M.A., Gupta, V., Kumar and Yogesh. (2019). A Success Story of Farmer's using Vermicomposting for Revenue and Employment Generation in Trans-Himalyas of Cold Arid Region. Int.J.Curr.Microbiol.App.Sci. **8** (04): 1283-1288. doi: https://doi.org/10.20546/ijcmas.2019.804.147

Zhang, H., Tan, S., Teo, C., Yew, Y., Ge, L., Chen, X. and Yong, J. (2015) Analysis of phytohormones in vermicompost using a novel combinative sample preparation strategy of ultrasound-assisted extraction and solid-phase extraction coupled with liquid chromatography-tandem mass spectrometry. *Talanta*. **139**. 189-197. 10.1016/j.talanta.2015.02.052.

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