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Influence of Micro organisms in production of vermicompost for environmental management

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ABSRACT

Present study had been conducted to observe effect of vermicompost feed (biodegradable waste) on microbial growth . Vermicomposting is a non thermo-philic bio-oxidative process. It involves earthworms and associated microbes. Vermicomposting enhances soil biodiversity by promoting growth of beneficial micro-organisms. This microbes enhances plant growth directly by production of plant growth regulators and enzyme. Indirectly vermicompost helps in controlling plant pathogens, nematodes and other pests. Vermicompost may be used to promote sustainable agriculture. The safe management of agriculture industrial and hospital wastes become today's burning issue and threat to environment. Present study reveals increased microbial count and N,P,K content of the soil.

Key Words : Vermicompost, microbes, agriculture, biodiversity, pathogens, soil.

Introduction:

A Country's progress is evident from its industrialization programmes. Industries form a major part of National Economy. With the advent of modern technology, increase production and rapid turnover of manufactured goods has been possible. However 2200 tones of organic waste which includes domestic garbage, industries waste, crop-straw, animal and human excreta produced in country; disposal of which is big challenge. The traditional methods of solid waste management by disposal in waste landfills; land remediation by earth cutting and soil excavation and use of agrochemicals are all highly expensive and also pollute the environment.

Composting is the decomposition of organic materials into nutrient rich soil. The process is started by bacteria and fungi which break down organic matter for their own food. The micro-organism needed for composting is found throughout the natural environment. They are present in compost, feedstock, water, air and soil. During composting process high diversity of microorganism help to maintain dynamic chemical and physical process of shifts in pH, temperature, water, organic matter and nutrient availability.

The sustainability refers to meeting the needs and aspirations of present generations without compromising the ability of future generations to meet their needs. Although, Darwin (1888) first drew attention to the great importance of earthworm in the decomposition of dead plants and release of nutrients from them. It is taken seriously as a field of scientific knowledge or even a real technology in recent years. Vermicomposting is mesophilic bio-oxidative process in which earthworms interact intensively with microorganisms and soil invertebrates. These together strongly affect and greatly modifying its physical and biochemical properties. Microorganisms produce the enzymes that cause biochemical decomposition of organic matter earthworms play a crucial role of indirect stimulation of microbial populations through fragmentation and ingestion of fresh organic matter. The compost prepared from organic materials using earthworm is a low cost and eco-friendly technology. This technology is promoted by some versatile chemically tolerant waste eater species of earthworm. Sir Charles Darwin called these species as unheralded soldiers of mankind who promises to provide the soft sustainable alternatives to some of those environmentally unfriendly hard civil engineering methods of development and waste management.

Vermicompost is granular peat like end product. It shows elevated levels of nitrogen, phosphorus and potassium (NPK) in available form, micronutrients, micro-flora, enzymes and growth regulators. When such vermicompost is applied to soil it improves crop growth and yield. Vermicompost is formed by joint action of earthworms and microbes. The use of vermicompost bring out several benefits to soil. Earthworm activity is closely associated with microbial activity. There exists a mutalistic association between earthworms and microorganisms, in deriving nutrition from biodegradable material. However, in present study microorganisms are not inoculated for enrichment of vermicompost. The process of vermicomposting results in the increase of microbial diversity and activity dramatically as it is source of plant growth regulators produced by interactions of microorganisms and earthworms. The studies on the microbial enrichment of vermicompost with respect to change in feed i.e. biodegradable waste material is the aim of present study. Study of the rate of production a vermicompost by changing feed i.e. vegetable waste and religious waste (i.e. Nirmalya) is also part of this project.

Materials and Methods:

Six plastic bins were taken. The contents of bicompost bed was same in all six bins. Each bin was filled with 2kgs of sand and soil (1 kg each). Small pieces of cow dung cakes form lowermost layer which was rested on rice husk and paper strips. Three such bins were taken for vegetable waste and three for religious waste (nirmalya).







Photo plates showing preparation of vermibins for microbial and fungal analysis





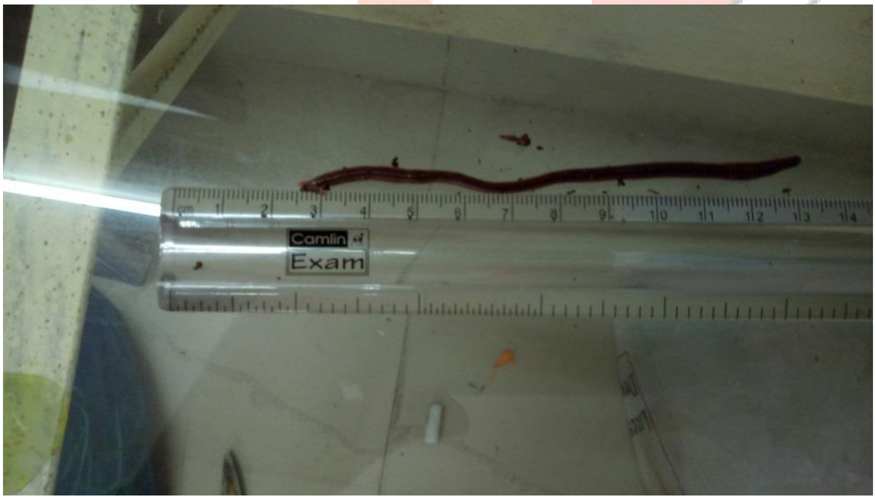

Photo plates showing Eisenia foetida (Earthworm) and composting material used during preparations of vermibed.

For Vegetable Waste:

Bin A	½ Kg feed (Chopped Vegetable)	1 Kg Mixture + 15 animals+ Soil	Finely Chopped Cow dung cakes
Bin B	1 Kg	1 Kg Mixture + 15 animals+Soil	Finely Chopped Cow dung cakes
Bin C	2 Kg	1 Kg Mixture + 15 animals +Soil	Finely Chopped Cow dung cakes

For Religious Waste (Nirmalya):

Bin A	½ Kg feed (Nirmalya)	1 Kg Mixture + 15 animals Soil	Finely Chopped Cow dung cakes
Bin B	1 Kg	1 Kg Mixture + 15 animals Soil	Finely Chopped Cow dung cakes
Bin C	2 Kg	1 Kg Mixture + 15 animals Soil	Finely Chopped Cow dung cakes

Healthy animals, Eisenia foetida wereintroduced in binswith all equal in size. No feed was added for 60 days. Everyday water was sprinkle to maintain moisture content.

Soil Analysis:

Soil analysis wascarried out by using Hi- media soil testing kit. Analysis was carried out for Initial(Day 1) soil sample as well as Final (after 60 days) vermicompost.

Microbial analysis:

Microbial analysis was carried out by using different cultural media as follows:

- Modified Nutrient Agar(NA) for bacterial population.
- Martins Rose Bengal Agar(RBA) for fungal population.

1gm of sample was dissolved in 9ml of sterile saline to follow serial dilution. The dilutions of 10^{-4}, 10^{-5} and 10^{-6} was taken sand spread by spread plate method over the sterile nutrient agar plate for bacterial count and incubated at 37^{0}C for 24 hrs. likewisethe dilution of 10^{-4}, 10^{-5} and 10^{-6} was taken and spread by spread plate method over the sterile Martins Rose Bengal Agar(RBA) for fungal count and incubated at 37^{0}C for 48 hrs.

Observation:

➢ **Physico-Chemical Analysis of Soil containing Vegetable waste:**

1. During the present investigation pH showed the alkaline nature in initial as well as in vermicompost(final soil sample).
2. Organic carbon content was 9.7 , 8.9 and 7.5 in sample A, B and C respectively. After 60 days in vermicompost organic carbon content was observed to be 10.2, 11.2 and 10.5 in sample A, B and C.
3. In the initial soil sample A, B and C nitrogen content observed was 0.3, 0.75 and 0.5 whereas, 0.4, 0.8 and 0.6 respectively in the vermicompost after 60 days.
4. Soil phosphorus in the initial sample A, B and C recorded was 0.8, 1.5 and 0.6 whereas, in vermicompost sample A, B and C 1.2 , 1.4 and 1.6 of phosphorus was observed.
5. Potassium content in intial soil A, B andC was found to be 0.3, 0.2 and 0.5 whereas, 0.2, 0.3 and 0.4 in vermicompost sample A, B and C after 60 days.

- **Physico-Chemical Analysis of Soil containing Religious waste(Nirmalya).**

1. During the present investigation pH showed the alkaline nature in initial as well as in vermicompost(final soil sample).
2. Organic carbon content was 10.00,9.20 and 8.50 in sample A, B and C respectively. After 60 days in vermicompost organic carbon content was observed to be 10.4, 11.5 and 10.5 in sample A, B and C.
3. Nitogen content in intial soil A, B andC was found to be 0.5, 0.7 and 0.4 whereas, 0.7, 0.6 and 0.6 in vermicompost sample A, B and C after 60 days
4. In the initial soil sample A, B and C phosphorus content observed was 0.8, 1.2 and 0.5 whereas, 1.4, 1.5 and 1.6 respectively in the vermicompost after 60 days.
5. Soil Potassium in the initial sample A, B and C recorded was 0.3, 0.3 and 0.5 whereas, in vermicompost sample A, B and C 0.2 , 0.4 and 0.6 of phosphorus was observed.

Microbial analysis:

- **Bacterial count:**

1. Vegetable waste:

In the initial soil sample A, B and C average bacterial count recorded in the initial soil sample was 162 x 10^5, 163.7 x 10^5 and 199.5 x 10^5cfu/g whereas, 166.4 x 10^5, 163.7 x 10^5 and 206.3 x 10^5 cfu/g respectively in vermicompost sample A, B and C after 60 days.

2. Religious waste:

Average bacterial count recorded in the initial soil sample A, B and C was 134.6 x 10^5, 129.7 x $10^5$and 129.8 x 10^5cfu/g whereas, in vermicompost(final) bacterial count recorded was 144.8 x 10^5, 136.6 x $10^5$and 136.2 x 10^5cfu/g respectively.

- **Fungal Count:**

1. Vegetable waste:

In the initial soil sample A, B and C average fungal count recorded in the initial soil sample was 110.2 x 10^5, 106.8 x 10^5 and 118 x 10^5 cfu/g whereas, 113.4 x 10^5, 108.7 x 10^5 and 121.5 x 10^5 cfu/g respectively in vermicompost sample A, B and C after 60 days.

2.Religious waste:

Average fungal count recorded in the initial soil sample A, B and C was 117 x 10^5, 133.5x $10^5$and 127.2x 10^5cfu/g whereas, in vermicompost(final) fungal count recorded was 144.8 x 10^5x 10^5, 138.1 x 10^5 and 132.4 x 10^5cfu/g respectively.

Table 1: Physico-Chemical Analysis of Soil containing Vegetable waste.

Parameter	Initial			Vermicompost(Final)		
	A	B	C	A	B	C
pH	7.5	7.6	7.6	8.5	8.6	8.3
Organic Carbon	9.7	8.9	7.5	10.2	11.2	10.5
Nitrogen (N)	0.3	0.75	0.5	0.4	0.8	0.6
Phosphors (P)	0.8	1.5	0.6	1.2	1.4	1.6
Potassium (K)	0.3	0.2	0.5	0.2	0.3	0.4

Table 2: Physico-Chemical Analysis of Soil containing Religious waste(Nirmalya).

Parameter	Initial			Vermicompost(Final)		
	A	B	C	A	B	C
pH	7.6	7.5	7.5	8.1	8.3	8.1
Organic Carbon	10.0	9.2	8.5	10.4	11.5	10.5
Nitrogen (N)	0.5	0.70	0.4	0.7	0.6	0.6
Phosphors (P)	0.8	1.2	0.5	1.4	1.5	1.6
Potassium (K)	0.3	0.3	0.5	0.2	0.4	0.6

Table 3: Bacterial Count in cfu/g of vermicompost treated with Vegetable Waste.

Dilution used	Sample A		Sample B		Sample C	
	Initial	Final	Initial	Final	Initial	Final
10^{-4}	60.2×10^5	65.4×10^5	63.5×10^5	67.3×10^5	72.4×10^5	74.2×10^5
10^{-5}	58.4×10^5	56.2×10^5	57.6×10^5	62.4×10^5	65.7×10^5	68.6×10^5
10^{-6}	43.4×10^5	44.3×10^5	42.6×10^5	58.3×10^5	61.4×10^5	63.5×10^5
Average	**162×10^5**	**166.4×10^5**	**163.7×10^5**	**188×10^5**	**199.5×10^5**	**206.3×10^5**

Table 4:Bacterial Count in cfu/g of vermicompost treated with Nirmalya.

Dilution used	Sample A		Sample B		Sample C	
	Initial	Final	Initial	Final	Initial	Final
10^{-4}	52.6×10^5	54.3×10^5	46.00×10^5	47.2×10^5	44.1×10^5	47.5×10^5
10^{-5}	45.2×10^5	48.1×10^5	43.4×10^5	45.00×10^5	43.2×10^5	45.3×10^5
10^{-6}	36.8×10^5	42.4×10^5	40.3×10^5	44.4×10^5	42.5×10^5	43.4×10^5
Average	**134.6×10^5**	**144.8×10^5**	**129.7×10^5**	**136.6×10^5**	**129.8×10^5**	**136.2×10^5**

Table 5: Fungal Count in cfu/g of Vermicompost treated with Vegetable waste.

Dilution used	Sample A		Sample B		Sample C	
	Initial	Final	Initial	Final	Initial	Final
10^{-4}	38.5×10^5	39.1×10^5	37.00×10^5	39.8×10^5	42.3×10^5	44.2×10^5
10^{-5}	36.4×10^5	37.3×10^5	35.6×10^5	36.4×10^5	38.5×10^5	42.3×10^5
10^{-6}	35.3×10^5	36.6×10^5	34.2×10^5	32.5×10^5	37.2×10^5	35.00×10^5
Average	**110.2×10^5**	**113×10^5**	**106.8×10^5**	**108.7×10^5**	**118×10^5**	**121.5×10^5**

Table 6: Fungal Count in cfu/g of Vermicompost treated with Nirmalya.

Dilution used	Sample A		Sample B		Sample C	
	Initial	Final	Initial	Final	Initial	Final
10^{-4}	43.5×10^5	56.7×10^5	58.4×10^5	56.2×10^5	48.2×10^5	52.7×10^5
10^{-5}	37.8×10^5	45.6×10^5	42.5×10^5	43.2×10^5	42.5×10^5	46.5×10^5
10^{-6}	35.7×10^5	42.5×10^5	32.6×10^5	38.7×10^5	36.5×10^5	33.2×10^5
Average	**117×10^5**	**144.8×10^5**	**133.5×10^5**	**138.1×10^5**	**127.2×10^5**	**132.4×10^5**

Discussion:

Microorganisms are the primary decomposers of organic matter. The role of microbial activity in the vermicomposting is degradation of organic waste and release of nutrients. Earthworms gut harbours specific symbiotic micro-flora. During the process of vermicompost the organic matter passes through the worm gut. These organic matter by the combined effect of microorganisms and earthworms undergoes to physical, chemical and biochemical changes. Earthworms help the proliferation of microbes by speeding up physical degradation process of organic matter when it passes through the gut. Organic matter that passes through the gut of earthworms released as vermicast results in an increased Microbial activity, enzyme activity and NPK enrichment Hendrickson (1990) and G. N. Emperor etal recorded high bacterial population in the earthworms cast. In accordance with their reports in the present study the bacterial population was found to be significantly greater in the fresh vermicompost obtained from vegetable waste.

The microbial count was found to be increased by the end the experiment. The bacterial population were higher in the midgut region than in the foregut and hindgut (B.E.Dakkiammel etal 2015) our observations on vermicast was in accordance with them.

Initially parameters of soil as well as microorganisms were checked to observe how vermicomposting increase the enrichment of N.P.K. content. In both vegetable waste as well as nirmalya (religious waste) the N,P,K content were found increased from initial stage to final stage. It is also found that when the feed amount was increased microorganisms as well as N,P,K value also increased (Table 1 and 2). This rise in activity was attributed to availability of more organic matter for decomposition. Similar observation were observed by Vidya Chavan et.al. (2013) in vermicompost.

The increased occurrence of fungal population in the compost is attributed to high rate of proliferation of fungi though earthworm selectively feed fungi (Scheu, 1987; Tiunov and scheu, 2000; G. N. Emperor and K. Kumar 2015). In conformity with the above observations in the present study also the fungal population was found higher in final (i.e. after 60 days).

Type of feed i.e., biodegradable material added plays an important role in decomposition. Table 3 and 4 represents bacterial count, which is high in vegetable waste feed while it is comparatively less in religious waste feed (mostly flowers). However fungal count is more in religious waste feed as compare to vegetable waste feed (Table 5 and 6)

In the present study, it was observed that bacterial count in vermicompost treated with vegetable waste and fungal count in vermicompost treated with nirmalya was increased in 60 day of composting. Similar observations were made by B. Easkkiammel etal (2015). The increased occurrence of fungal population in the cast was attributed to high rate of proliferation of fungi even though earthworms selectively feed fungi. Microorganisms are the main agents of biochemical decomposition. Earthworms are involved in indirect stimulation of microbial population by increasing the surface area available for microbes through fragmentation. This was the reason we got comparatively less microorganisms in religious feed. Further, it was also observed that religious waste (mainly flowers) highly support the growth and multiplication of fungi than microorganisms.

Conclusion:

Bhiwandi is one of the major cities which is famous for textile-dyeing industries. Due to industrialization and increase in population, huge amount of wastes is produced. There are two major market areas where vegetable and fruits are sold. These contribute to production of organic waste on large scale. Nirmalya (religious waste) produced on large scale is also major issue of concern. Since this waste is usually release into water bodies leading to eutrophication conversion of such waste into compost using earthworms can good solution to minimize pollution cause by Nirmalya. Vermicomposting as part of biotechnology helps in maintaining environmental balance and leaves no adverse effect.

Vermicomposting is cost-effective and eco-friendly waste management technology. It takes the privilege of both earthworms and associated microbes. It has many advantages over traditional composting. Vermicompost is the physicochemical and biological properties of agricultural soil. Vermicompost amplifies the diversity and population a beneficial microbial communities. Increate in the organic waste mainly due to growth of human population, agriculture and industries is global problem. Experiments with worms can recycle the utilizable organic wastes arising out of house-hold garbage, city refuge, sewage sludge and paper, fired and wood industries. Our study proves that earthworms involved in indirect stimulation of microbial population.

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