Comparative Study of Microbial population in Vermicompost and Biocompost in Relation with Physicochemical Parameters

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Abstract: The study was focused on quantitative estimation of microorganisms in vermicompost and biocompost and if earthworm presence has any impact on microbial growth. The physicochemical parameters such as pH, Temperature, Organic matter, Nitrogen(N), Phosphate (P), Potassium (K) were also analyzed to determine the effect of microbial activity. There is extensive evidence in the literature that earthworms and other soil invertebrates feeding on microorganisms enhance microbial activity in the first instance. As a result of it, earthworms reduce the availability of these resources for the microbial communities and consequently their activity, in later stage.

Many authors have recorded higher microbial populations in the partially decomposed vermicompost than completely formed vermicompost. This may be due to the temperature and pH conditions in the partially decomposed raw material. Compared to conventional thermophilic composts, vermicompost is much richer in microbial diversity, populations and activities (Subler *et al.* 1998).

Keywords: Vermicompost, Biocompost, Microbial activity, Earthworms, Organic wastes.

Introduction

Vermicomposting is a mesophilic bio-oxidative process in which detritivorous earthworms interact intensively with microorganisms and soil invertebrates within the decomposer community, strongly affecting decomposition processes, accelerating the stabilization of organic matter and greatly modifying its physical and biochemical properties. Vermicomposting systems sustain a complex microbial and invertebrate food web that results in the recycling of organic matter and release of nutrients. Biotic interactions between decomposers(i.e. bacteria and fungi) and the soil fauna include competition, mutualism, predation and facilitation and the rapid changes that occur in both functional diversity and substrate quality are the main properties of these systems(Sampedro and Domínguez, 2008). The most numerous and diverse members of this food web are microorganisms, although there are also abundant protozoa and many invertebrates of varying sizes, including nematodes, microarthropods and large populations of earthworms(Monroy 2006; Sampedro and Domínguez 2008). These invertebrates cover a range of trophic levels-some feed primarily on microbes (bacteriovores and fungivores), on organic waste (detri-tivores) or on a mixture of organic matter and microbes (microbio-detritivores), whereas others feed on animals (carnivores) or across different trophic levels (omnivores); (Sampedro and Domínguez 2008).

The primary consumers of the vermicomposting food web are the microorganisms (mainly bacteria, fungi and ciliates) that break down and mineralize organic residues. Microorganisms are the most numerically abundant and diverse members of the vermicomposting food web and include many thousands of different organisms. Secondary and higher-level consumers, that is, the soil invertebrates, including earthworms, exist together with microbes, feeding on and dispersing them throughout the organic matter. Endosymbiotic microbes produce extracellular enzymes that degrade cellulose and phenolic compounds, enhancing the degradation of ingested material and the degraded organic matter passes out of the earthworm's body in the form of casts. As decomposers die, more food is added to the food web for other decomposers. Earthworms accelerate decomposition processes during vermicomposting (Aira *et al.* 2006, 2007).

The effect of earthworms on the decomposition of organic waste during the vermicomposting process is, in the first instance, due to gut-associated processes (GAPs). These processes include all the modifications including the addition of sugars and other substances, modification of the microbial diversity and activity, homogenization and the intrinsic processes of digestion, assimilation and production of mucus and excretory substances such as urea and ammonia, which constitute a readily assimilable pool of nutrients for microorganisms. The proximate activities of earthworms enhance the mineralization of both carbon and nitrogen in the substrate significantly and such effects are in proportion to the earthworm population densities (Aira *et al.* 2008).

In addition, carbon availability is a limiting factor for earthworm growth and it has been reported that earthworms and microorganisms may compete for carbon resources (Tiunov and Scheu 2004); thus earthworm activity may have reduced the quantity of resources available for microbial communities and consequently the bacterial growth rates.

Materials and Methods

Vermicompost and Biocompost Bed

Two plastic bins were taken and covered with nylon mesh for proper aeration. The contents in both the bins were same except vermiculture (1 & ½ kg) and *Eisenia fetida* worms (12 worms of around 7 to 10 cm size) were added in vemicompost bin. Brick pieces of around 2 cm size formed the first layer (500 gm) of both bins. Around 1 & ½ kg baggase was added as second layer followed by dry hay layer (500 gm) and Cabbage waste of around 2 kg. Small pieces of dry cowdung (1 Kg) were added. Between all these layers soil was sprinkled in both bins, again around 50 gm of soil was spread at top of both bins. Watering was done daily to maintain moisture content.

Physicochemical analysis: The physiochemical parameters of vermicompost and biocompost bins were also analyzed after 15 days time interval including initial parameters of soil. Table 1 gives methods used for analysis of chemical parameters.

Table 1: Methods used for analysis of chemical parameters

Sr. No.	Parameters analyzed	Method used
1.	Organic contents	Walkey and black method.(Trivedi R.K & Goel 1986)
2.	Nitrogen(N)	Kjeldahl method (Trivedi R.K & Goel 1986).
3.	Phosphorus(P)	Olsens method (Trivedi R.K & Goel 1986).
4.	Potassium(K)	A flame photometry (Trivedi R.K & Goel 1986).

Microbial analysis: First Sample was collected for analysis 15 days after the set up of vermicompost and biocompost, second and third samples were also taken by keeping 15 days gap between them, to complete 60 days study (i.e. initial setup to 3rd sample). For observing microbial growth Sterile Nutrient agar plates were used. 1 gm of sample was dissolved in 9 ml of sterile saline. The Serial dilution (10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6}) up to 10^{-6} was carried out. Then 0.1 ml of sample from the 10^{-4}, 10^{-5} and 10^{-6} was taken and spread by Spread plate method over the sterile Nutrient Agar plate and Incubated at R.T. for 24 hours and microbial count was done.

Result and Discussion:

The sterile nutrient agar plates after an incubation period of 24 hours at room temperature showed a crowded plate on first sampling i.e. during initial stages of formation of vermicompost and biocompost. Table2. shows the total count of Colony Forming Unit (CFU) per gram of vermicompost samples for 10^{-4}, 10^{-5}, 10^{-6} dilutions.

The CFU count was higher at initial stages while it was getting decreased further. Thus the microbial population was found higher at initial stages, which may be because after digestion of organic material the vermicasts formed; providing large quantity of material to decompose and large surface area for microbes to adhere to the substrate; microbes from earthworm's gut i.e. enteric microflora also get added to the microbial population. After the formation of vermicompost and degradation of organic matter, the food chain in vermicompost and biocompost starts working i.e. the microbes and other soil invertebrates compete for available resources (i.e. C, N, P, O) to sustain their lives, thus the microbial population starts decreasing. The total CFU counts of biocompost were determined. Table 2. represents the total CFU/g count of vermicompost and biocompost for 45 days with 15 days time interval in each sampling.

Table 2: Total CFU/g count for vermicompost and biocompost

Dilution used	10^{-4}		10^{-5}		10^{-6}		Average	
	Vc	Bc	Vc	Bc	Vc	Bc	Vc	Bc
Sample 1 CFU/g	1.64×10^6	3.1×10^6	10×10^6	4.5×10^6	80×10^6	24×10^6	30.54×10^6	10.53×10^6
Sample 2 CFU/g	1.45×10^6	2.7×10^6	9×10^6	4×10^6	68×10^6	20×10^6	26.15×10^6	8.9×10^6
Sample 3 CFU/g	1.38×10^6	2.4×10^6	7.7×10^6	3.2×10^6	61×10^6	18×10^6	23.36×10^6	7.86×10^6

The comparative study showed that microbial population in biocompost was much lower as compared to vermicompost. This may be due to the presence of earthworms in vermicompost, as they act a good supporters for microbial growth i.e. by providing, a large pool of resources such as N, P, K, provide larger surface area by digesting organic material and degrade it into smaller pieces; also the earthworm activity or movement through vermin bin provides proper aeration. Thus a favorable medium was provided for microorganisms to grow. Fig.1 represents the comparative account of microbial populations in vermicompost and biocompost.

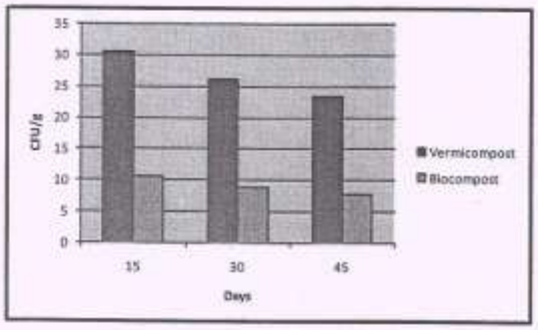

Fig.1: comparison between CFU/g counts of vermicompost and biocompost

The physiochemical parameters such as pH, Temperature, N, P, K contents and Organic matter were also analyzed. Initial parameters of soil were analyzed to determine the impact of compost formation on soil on both vermicompost and biocompost. The pH of both vermicompost and biocompost was found to be in the range of 5 – 7 and 4 – 7 respectively during the process. The Slight change in pH from slightly acidic to neutral is due to increase in NPK content or Organic matter content. The temperature in both the bins showed an increase from 15°C to 25°C which may be due to the heat generated during decomposition, digestion and respiration of microorganisms and earthworms. Table3. showed the physiochemical parameters in both vermicompost and biocompost

Table 3.: The Physicochemical parameters of Vermicompost and Biocompost

Analysis	1		2		3		4	
	Vc	Bc	Vc	Bc	Vc	Bc	Vc	Bc
pH	5 – 6	4 – 5	5 – 6	4 – 5	6 – 7	5 – 6	6 – 7	6 – 7
Temperature	15°C–25°C	18°C–27°C	15°C–23°C	18°C-25°C	18°C–24°C	16°C–23°C	16°C–24°C	15°C–25°C
Organic contents %	9.8	6.5	10.1	8.9	11.2	10.3	11.5	10.52
N %	0.51	0.32	0.75	0.43	1.25	0.68	1.45	1.8
P %	0.91	0.67	1.24	0.83	1.63	1.3	2.12	1.4
K %	0.15	0.1	0.27	0.12	0.39	0.21	0.46	0.32

The organic matter content of both the Bins was found to be increased from initial concentration of 6.5% to 11.5% and 10.52% for vermicompost and biocompost respectively. Fig 2 showed comparison between Organic matter contents of vermicompost and biocompost.

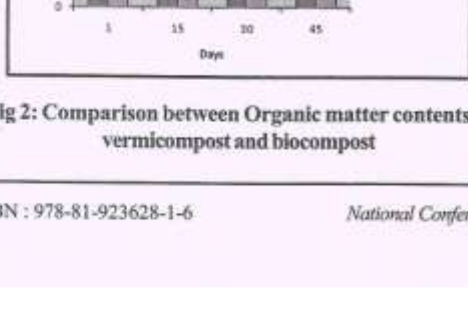

Fig 2: Comparison between Organic matter contents of vermicompost and biocompost

The N, P, K content in both vermicompost and biocompost were found to be increased from initial concentration of 0.51% to 1.8% in Vermicompost and 0.32% to 1.45% in biocompost respectively. It has followed an increasing trend for all the phases in development of Vermicompost and biocompost. In vermicompost the NPK content was found higher as compared to biocompost. Higher 'N' content may be due to the presence of earthworms, as, the Nephridial secretions of earthworms produce Nitrogenous compounds in their digestive tract which finally get mixed up with vermicomposting material, increasing the 'N' content. P and K content also followed an rising trend in all phases. Again it is found higher in vermicompost compared to biocompost. Fig 3 represents comparison of N, P, K contents in % of vermicompost and biocompost.

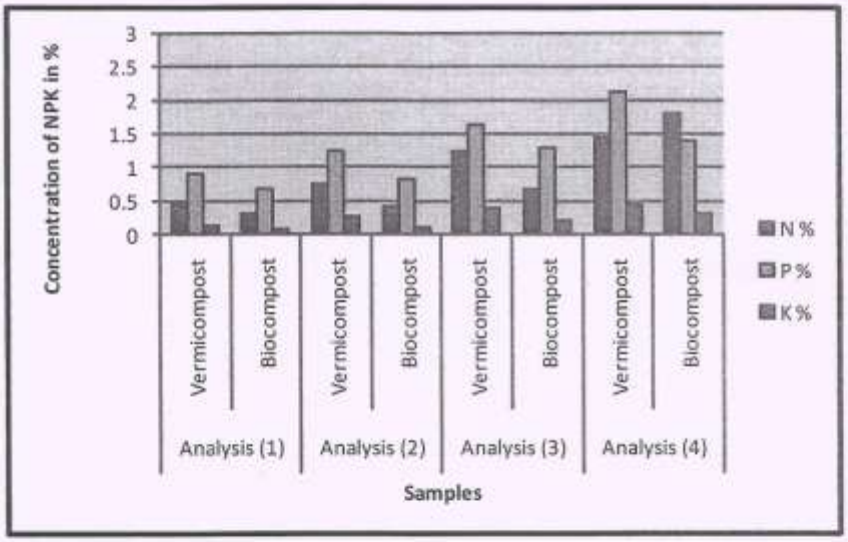

Fig 2: Comparison of NPK contents in % of vermicompost and biocompost

Conclusion: The study proves that, earthworms act as crucial drivers of the process and are involved in the indirect stimulation of microbial population, Earthworms activity helps microbial communities to use available energy more efficiently, thus enhancing the quality of final product i.e. vermicompost which can be used as best biofertilizer.

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