

# **Review on Bacterial Biodegradation of Municipal Solid Waste Management in India**

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**ABSTRACT:** Biodegradation is alternative way to manage or to degrade the Municipal Solid Waste Management (MSWM). It is eco-friendly and much cost effective is compared to other traditional technique such as incineration and composting. The main purpose of this paper is to pay more attention towards biodegradation of MSWM in Indian cities. Municipal Solid Waste (MSW) consist lots of waste such as household garbage and rubbish, street sweeping, agricultural waste, construction and demolition debris, sanitation residues, trade and non-hazardous industrial refuse and treated bio-medical solid waste. Review of this paper focused characteristics, collection, transportation, disposal and different microbial process of biodegradation, their limitation and the process to microbial different MSW dumping sites and these isolates could be vital sources for the microbial diversity is stated here and discussed.

**KEYWORDS:** Municipal solid waste management, Bacteria, biodegradation

## **I. INTRODUCTION**

Municipal Solid Waste Management (MSWM) has become a critical area of practice and research due to the increasing concern of environmental pollution and resources shortage Brewer, 2001. [4] Every day huge quantities of waste materials are generated in all cities and municipal areas of India. Various types of waste are causing adverse effect on living organisms and environment. As a result, human and animal diseases occur, the air and soil environment are spoiled and the entire natural ecosystem balance is disturbed Zaved et al., 2008. [12] NILG, 2002. [9] According to EPA in 1989, only 10% of this MSW is being recycled, while 80% goes in to landfills, and 10% is incinerated.

Biodegradation is nature's way of recycling wastes, or breaking down organic matter into nutrients that can be used and reused by other organisms. In the microbiological sense, "biodegradation" means that the decaying of all organic materials is carried out by a huge assortment of life forms comprising mainly bacteria, actinomycetes, fungi, algae and protozoa. Among these groups, bacteria are the most abundant group Alexander, 1999. [2] Alexander, 1961. [1] and the most important microbe for decomposing waste. Bacteria use wastes for their own metabolism and finally they produce hazardous toxic chemicals into non-toxic or less toxic substances which are important for soil health, plant growing and over all to keep well balance of natural ecosystem. In a very broad sense, in nature, there is no waste because almost everything gets recycled. In addition, the secondary metabolites, intermediary molecules or any 'waste products' from one organism become the food/nutrient source(s) for others, providing nourishment and energy while they are further working-on/breaking down the so called waste organic matter. Some organic materials will break down much faster than others, but all will eventually decay.

Number of microbes along with rodents and insects play a vital role for solid waste degradation. Among them, bacteria play the most important role and therefore, the effective bacteria can be employed for planned decomposition

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of solid organic waste. In most of the Indian cities, the MSWM system comprises waste generation, collection, transportation and disposal. The management of MSW requires proper infrastructure, maintenance and upgrade for all activities. These become increasingly expensive and complex due to the continuous and unplanned growth of urban centers. The difficulties in providing the desired level of public service in the urban centers are often attributed to the poor financial status of the managing municipal corporations.

## II. LITERATURE SURVEY

Janarthanan et al., 2014. [8] Reported 40 different bacterial strains were isolated and identified. Table-1, Figure-1 and 2 (include a, b, c) shows the results among the strains *Bacillus* spp., and *Micrococcus* spp., (amylase producing bacteria) were identified as efficient starch hydrolyser and those were completely composed the market waste in very short duration when compared to the normal soil micro flora. This research also revealed compost the NPK level was increased significantly.

S.No	Layer	Compost – I		Compost – II	
		Sterilized Soil with <i>Bacillus</i> Sp B17	Kg	Non – Sterilized Soil	Kg
1	I	Vegetables waste	600g	Vegetables waste	600g
2	II	Soil	1.5g	Soil	5g
3	III	Vegetables waste	600g	Vegetables waste	600g
4	IV	Soil	1.5g	Soil	1.5g
5	V	Vegetables waste	600g	Vegetables waste	600g
6	VI	Clay Soil	1Kg	Clay Soil	1Kg

Table-1. Formation of Soil and Market Waste layers for compost preparation for screening amylase producing organisms.

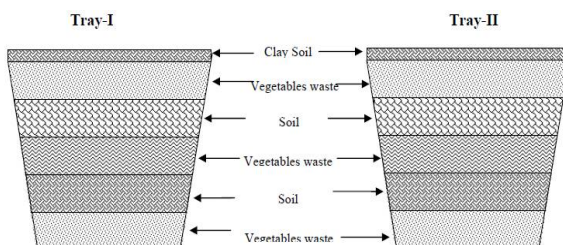


Figure-1. Graphical model for compost formation

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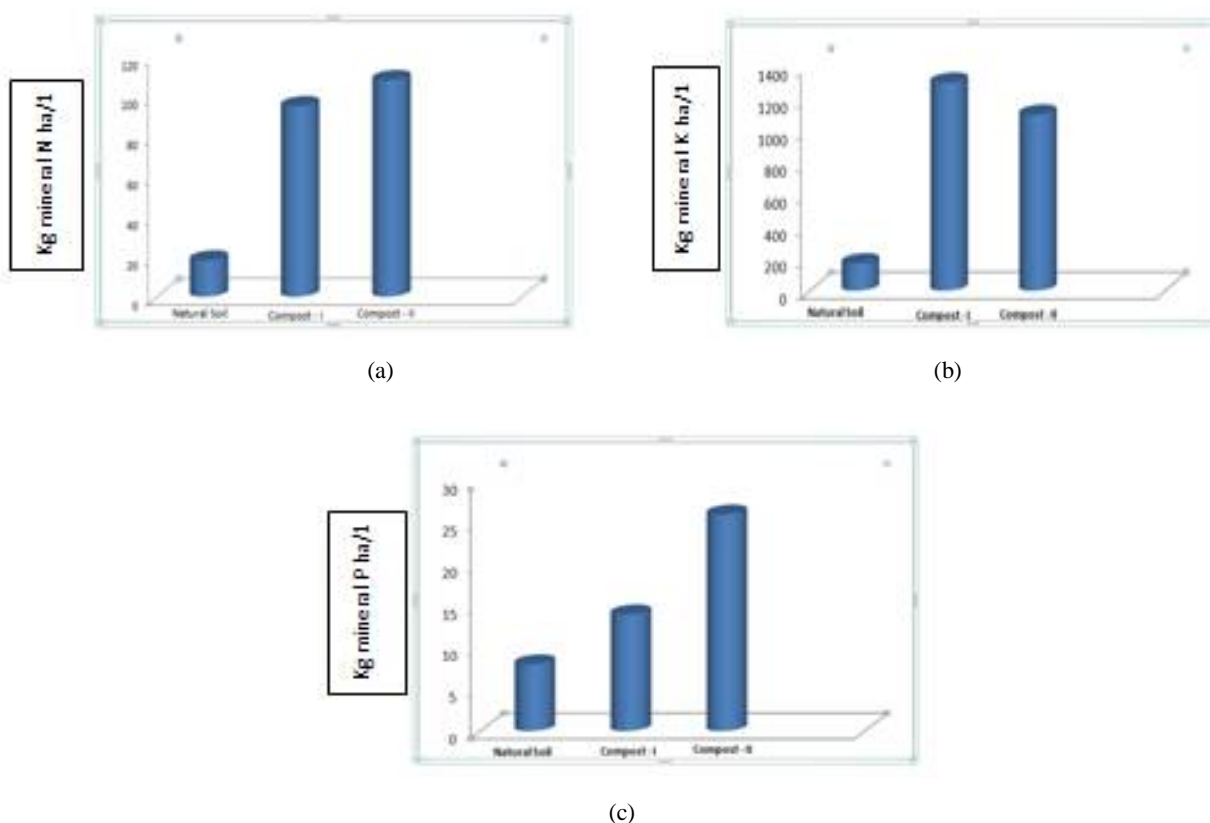


Figure-2. (a). Nitrogen (N), (b). Phosphorus (P), and (c). Potassium (K) Levels in Natural Soil, Compost-I and Compost-II  
Janarthanan et al., 2014 [8]

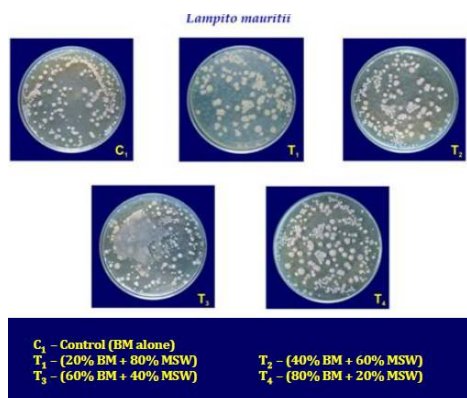
In 2015. [11] Sriramulu Ananthkrishnasamy and Govindarajan Gunasekaran discussed the population of bacteria, fungi and actinomycetes are found to increase in vermicomposting process shows in the following Figure-3 to 5, when organic matter passes through the worms gut it undergoes physical, chemical and biochemical changes by the combined effect of earthworm and microbial enzymatic activities. Both of them also revealed that the role of microbial activity in the gut as well as in the casts is very essential for the degradation of organic wastes and release of nutrients to the plants. The size of microbial population in worms casts is mainly depends on the type and quality of ingested soil and plant materials. These research reports may be encourage to the researchers to work further improvement of the research study.

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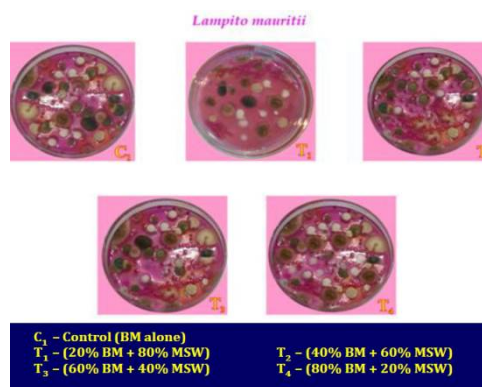
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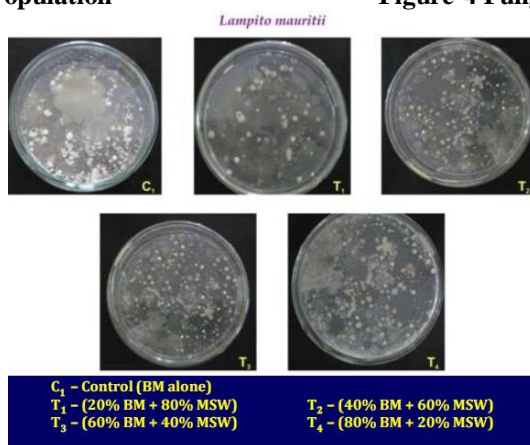
Vol. 6, Issue 1, January 2017



**Figure-3 Bacterial Population**



**Figure-4 Fungal Population**



**Figure-5 Actinomycetes Population**

Sriramulu Ananthkrishnasamy and Govindarajan Gunasekaran, 2015 [11]

In the year 2015 Atalia et al., [3] gives the physicochemical and microbiological qualitative and quantitative analysis of dumped solid waste at both the field land sites proved partial spontaneous to almost biocompost due to long time span of accumulation. The study is concluded the mud samples of both the field land sites consists comparatively higher microbial population and wide diversified microbial community with wide nutritional catabolic profile given in Table-2. This research study may be beneficial to encourage the competent researchers to work towards further improvement of the present system.

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Vol. 6, Issue 1, January 2017

Sr. No.	Sample	Microbial total count microscopically 10 <sup>-6</sup> dilution under 100X	Viable count N-Agar plate	Amylo-lytic colonies	Cellulo-lytic colonies	Ligninolytic colonies		Pectino-lytic colonies	Proteo-lytic colonies	Lipido-lytic colonies	Chitin-lytic colonies
				Starch Agar plate	Cellulose Agar plate	Tannin Agar plate	Lignin Agar plate	Pectin Agar plate	Gelatin Agar plate	Tributyryn Agar plate	Chitin Agar plate
1.	Pirana fieldland: Mud Sample	Protozoa: 7-8 Yeast: 5-9 Fungi: 17-22 Bacteria: 20-30	328	140	86	41	12	07	18	10	05
2.	Gyaspur fieldland: Mud Sample	Protozoa: 5-6 Yeast: 5-9 Fungi: 18-20 Bacteria: 19-25	352	129	75	46	14	09	22	06	03
3.	Hotel garbage	Protozoa: 4-5 Yeast: 7-10 Fungi: 19-25 Bacteria: 28-34	558	196	18	06	02	15	138	21	01
4.	Fruit market garbage	Protozoa: 3-5 Yeast: 11-16 Fungi: 24-28 Bacteria: 32-38	418	137	62	14	03	75	78	13	00
5.	Vegetable market garbage	Protozoa: 2-6 Yeast: 6-10 Fungi: 20-25 Bacteria: 30-35	368	176	85	25	09	48	62	10	00

**Table-2 Catabolic properties of microbial community of solid waste samples (10<sup>5</sup> dilution).**  
Atalia et al., 2015 [3]

In 2012, Gautam et al., [6] reported a potential strains used for biodegradation of organic MSW. In this biodegradation study also revealed Forty nine out of the 250 different microbes tested (165 belong to fungi and 85 to bacteria) produced cellulase enzyme and among these *Trichoderma viride* was found to be a potential strain in the secondary screening. Figure-6 and 7 shows the biodegradation of organic waste, after 60 days, the average weight losses were 20.10% in the plates and 33.35% in the piles. It also increases in pH until 20 days, however, pH stabilized after 30 days in the piles. Temperature also stabilized in the piles. The high temperature continued until 30 days of decomposition, after which the temperature dropped to 40°C and below during the maturation and then good quality compost was obtained in 60 days. This study useful to analyze optimum activity of MSW biodegradation by using microbes. Gautam et al., (2010) [5] also evaluate fourteen bacterial and fungi isolates were screened from MSW and characterized to develop effective consortia and their efficacy to produce enzyme at different temperature and pH were studied. They are concluding the tree isolates of *Pseudomonas sp.*, *Trichoderma viride* and *Trichoderma sp.*, used to develop microbial consortia for composting process.

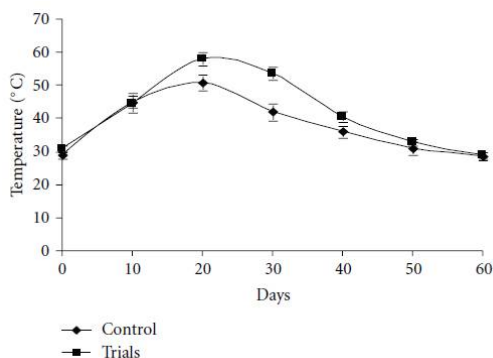


Figure-6 Variation of pH during the bioconversion of MSW.

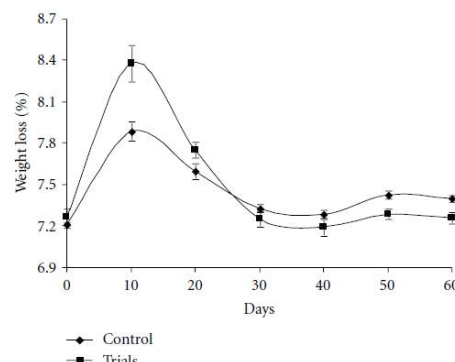


Figure-7 Variation of temperature during the bioconversion of MSW.

Gautam et al., 2012 [6]

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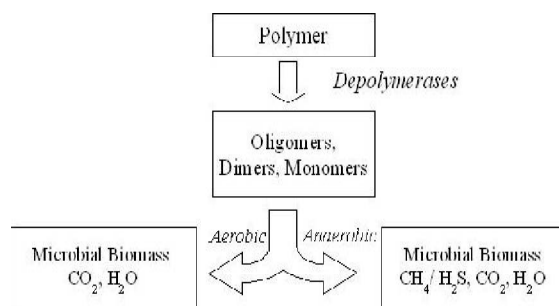
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Vol. 6, Issue 1, January 2017

Jeyapriya and Saseetharan 2007. [7] Studied the magnitude and the physicochemical analysis of Municipal Solid Waste in Coimbatore city. The results of the study showed that the biodegradable fraction of MSW was high with an average value of 68.94 percent. High percentage of volatile solid content revealed that the organic content in the waste material was high and the solid waste had an optimum C:N ratio of 30:1. They also analyzed the biochemical parameters of MSW biocompost. The MSW biocompost was found to contain a moisture content - 27.0%; pH - 7.66; EC - 1.13 dSm<sup>-1</sup>; total nitrogen - 1.34%; phosphorus - 0.58%; potassium - 1.12%; OC - 24.28%; C : N ratio - 19 : 1; magnesium - 1.33%; calcium - 2.36%; Bacteria - 58 (106 C F U g<sup>-1</sup> dry soil); Fungi - 28 (106 C F U g<sup>-1</sup> dry soil) and Actinomycetes – 22 (106 C F U g<sup>-1</sup> dry soil).

In the year 2014, Sher Singh Gill et al., [10] analyzed anaerobic bacterial treatment has favourable effects like removal of higher organic concentration, low sludge production, higher pathogenic removal, higher biogas production and low energy consumption. The continuously fed digester requires addition of sodium hydroxide to maintain the alkalinity and neutral pH (7.0). They conclude hydrolysis, acidogenesis, acetogenesis and methanogenesis of kitchen bio-waste digesting anaerobic bacterial flora.



Sher Singh Gill et al., 2014 [10]

### III. CONCLUSION

India has large resources of techniques and facilities but due to the lack of attention towards the Municipal Solid Waste Management System. The present review bacterial biodegradation of MSW could be seen as an option of waste management in Indian cities. Due to the increase in the generation of MSW, proper management has to be adopted in order to minimize the generation. Managing waste at source is more important than the conventional way of handling waste. Bacterial biodegradation is one of the effective methods to treat the MSW, in addition to being eco-friendly, wealth creating and a sustainable method.

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