AN EXPERIMENTAL STUDY TO ASSESS VERMICOMPOSTING BY USING VEGETABLE WASTE AND FRUIT WASTE

Manikandan.T[1], Arun.M[2], Meyyappan.P[3], Kathiravan.C[4]

[1]Assistant professor of Civil Engineering, [2, 3, 4] Under Graduate Final Year students
Sembodai Rukmani Varatharajan Engineering College, Sembodai – 614809
Vedaraniyam (Tk), Nagapattinam (Dt), Tamilnadu, India

Abstract - *The present trend about waste management is to focus on recycling and the recovery of waste as new materials or as energy. The vermicomposting of these by-products is more encouraged to avoid the loss of energy. Earthworms feed on the organics and convert material into casting rich in plant nutrients. The chemical analyses of casts show two times available magnesium, 15 times available nitrogen and Seven times available potassium compared to the surrounding soil. However, for safe application of vermicomposting on soil, not only the quality of products should be including stable, but also the vermicomposting must be mature.*

The source of materials and the biological activity associated with composting and vermicomposting make it extremely difficult to assess the rate of compost/vermicomposting application and its suitability as a soil amendment. Some of the parameters that have been used to measure the maturity include changes in nitrogen species, pH, optical density, temperature, specific gravity, plant assays, respiration, and microbial population changes. The vermicomposting using earthworms (Eisenia - Fetida) was produced from food waste and fruit waste with chemical parameters (EC, pH, carbon to nitrogen contents (C/N)) and germination bioassay was examined in order to assess the stability and maturity indicators during the vermicomposting process.

***Key Words*: Earth worms, vermicomposting, market waste, natural manure.**

1.INTRODUCTION

MSW is defined as any waste generated by household, commercial and/or institutional activities and is not hazardous. India is the second largest nation in the world, with a population of 1.21 billion, accounting for nearly 18% of world's human population, but it does not have enough resources or adequate systems in place to treat its municipal solid waste. Its urban population grew at a rate of 31.8% during the last decade to 377 million, which is greater than the entire population of US, the third largest country in the world according to population. India is facing a sharp contrast between its increasing urban population and available services and resources. Solid waste management (SWM) is one such service where India has an enormous gap to fill. Proper municipal solid waste (MSW) disposal systems to address the burgeoning amount of wastes are absent. The current SWM services are inefficient, incur heavy expenditure and are so low as to be a potential threat to the public health and environmental quality.

In India, average organic waste components holds nearly (55 - 60 %) of total wastes of MSW. on that organic wastes like vegetables, fruits are alone nearly 30%. Other components like inorganics, recyclables, non- recyclables, plastics and other inert materials holds 35-40% of total volume. Instead of disposing or dumping organic waste, adopting suitable treatment effects 60% of volume reduction, or management. The typical average Municipal solid waste components from all cities of India is given in figure 1.1.

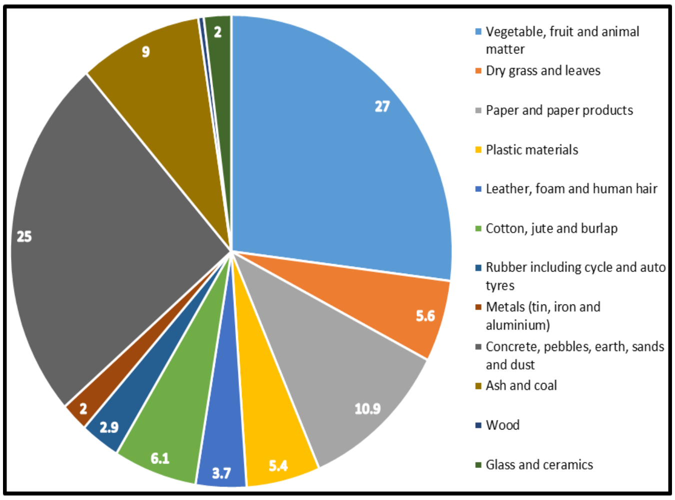

Fig – 1 Typical average MSW components from all Indian cities

1.1 Impact of Urbanization on MSW generation :

Population growth and rapid urbanization means bigger and denser cities and increased MSW generation in each city. A Total of 366 cities in India were generating 31.6 million tons of waste in 2001 and are currently generating 47.3 million tons, a 50% increase in one decade. It is estimated that these 366 cities will generate 161 million tons of MSW in 2041, a five-fold increase in four decades. At this rate the total urban MSW generated in 2041 would be 230 million TPY (630,000 TPD). Impact of Urbanization on MSW generation as shown in figure 1.2.

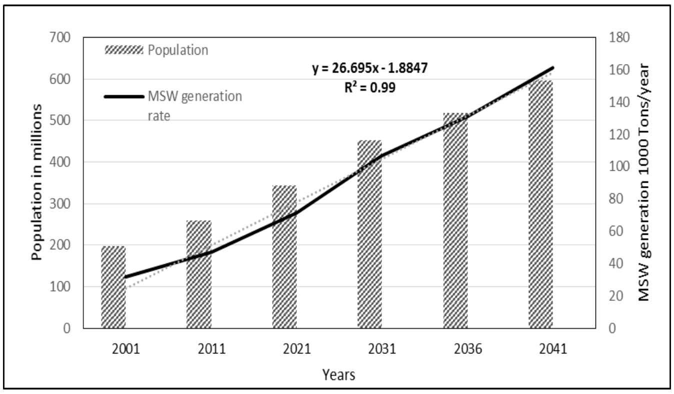

Fig 2 Population Growth and respective solid waste generation rate in India

A 1998 study by TERI (The Energy Resources Institute, earlier Tata Energy Research Institute) titled 'Solid Waste Management in India: options and opportunities' calculated the amount of land that was occupied by waste disposed post-independence, until 1997. Based on a estimation of business as usual (BAU) scenario, the waste generated by 2001 would have occupied 240 sq.km or an area half the size of Mumbai; waste generated by 2011 would have occupied 380 sq.km or about 220,000 football fields or 90% of Chennai, the fourth biggest Indian city area-wise; waste generated by 2021 would need 590 sq.km which is greater than the area of Hyderabad (583 sq.km), the largest Indian city, area-wise. The Solid Waste Management Sector in India, published by Ministry of Finance in 2009, estimates a requirement of more than 1400 sq.km of land for solid waste disposal by the end of 2047 if MSW is not properly handled and is equal to the area of Hyderabad, Mumbai and Chennai together.

1.2 Solid waste generation in Tamilnadu

Tamilnadu is one of the 29 states of India, its capital and largest city is Chennai. Tamilnadu lies in the southernmost part of the Indian peninsula and it is bordered by the union territory of puducherry and the south Indian states of Kerala, Karnataka, and Andhra Pradesh. It is the 11-th largest state in by area and sixth most populous. The state was ranked sixth among states in India according to the human development index in 2011 with second largest state economy. The population density of the state is 1600 sq. mi. Due to the high density population and rapid industrialization, the state faces high solid waste generation at the rate of 14588 TPD (Tonnes per day), municipalities around 3700 TPD and town panchayat is around 1900 TPD and the average per capita solid waste generation is 0.25 kg. Status of ULB's with respect to MSW Rules in the state of Tamilnadu as shown in Table 1.3.

Corporation cities of Tamilnadu generates more solid waste compared to other districts and cities and it also holds half of the solid waste generation in the state. On that, Chennai City Corporation generates 5000 tons per day without any prior treatment wastes are simply dumped into dumping yard. Upsurge of waste generation in Chennai causes very serious environmental pollution.

2. LITEREATURE REVIEWS

India is the second largest producer of fruits and vegetables in the world with 221.431 million metric tonnes. The cumulative wastages are estimated to be 5.8 to 18 % of the total produced fruits and vegetables (Varma & Kalamdhad, 2016). Landfilling and open dumping of wastes on the outskirts of towns and cities remain as the primary disposal strategy in India. When these wastes, with huge organic content, are disposed of in open dumps or in landfills, they pose a significant environmental problem by emitting greenhouse gases, and also lead to leachate production. Moreover, this open dumping is becoming impractical due to public consciousness, and also expensive due to transportation and unavailability of lands. Therefore, vegetable waste with high organic content and rich nutrient content can be successfully recycled through vermicomposting and composting processes, as compared to many other technologies (Garg and Gupta, 2011).

There are several literature reports available on the utilization of vegetable waste along with cattle manure, saw dust and dry leaves for the enhancement of composting and vermicomposting process (Garg and Gupta, 2011, Suthar, 2007). It has been reported that appropriate combinations and proper agitation during operation provided optimum conditions for the higher degradation of organic matter (Kalamdhad et al, 2009). However, during vermicomposting, the earthworms ingest the organic waste and convert them into humus-like material termed vermicast, containing N, P and K in such forms that they are more available to plants than those in the initial raw substrate (Ravindran et al, 2016; Singh et al, 2010). Composting is the biological decomposition of organic matter forming a stabilized and pathogen free end product. The transformation and mineralization of organic matter during composting is reported to be carried out by many microbial communities, such as bacteria, fungi and actinomycetes (Varma & Kalamdhad, 2016).

3. METHODOLOGY AND MATERIALS

The methodology of the work is followed as:

1) Selection of title
2) Literature review through related journals
3) Purchase of earth worms
4) Preparation of Vermi bed
5) Preliminary test such as temperature Etc.,
6) Collection and measurement of Natural manure
7) Consolidated results and discussions
8) Conclusions

3.1 Materials

Materials suitable for preparation of vermicompost

1. Crop residues and leaf litter
2. Weed biomass
3. Vegetable waste
4. Hostel refuse and organic waste

Basic needs of worm

1. Bedding material (material that provides relatively stable habitant)
2. Aeration (either natural or artificial means)
3. Temperature (room temperature 25 ± 2˚ C)
4. Food source (organic wastes rich in lignin content)
5. Moisture (55- 65 %)

The nutrient content in vermicompost vary depending on the waste materials that is being used for compost preparation. If the waste materials are heterogeneous one, there will be wide range of nutrients available in the compost. If the waste materials are heterogeneous one, there will be only certain nutrients are available. The common available nutrient contents in vermicompost is as shown

Sl.no	Nutrients	Unit
1	Organic carbon	9.5-17.98%
2	Nitrogen	0.5-1.50%
3	Potassium	0.15-0.56%
4	Sodium	0.06-0.30%
5	Calcium & magnesium	22.67 – 47.60 mg/100g
6	Iron	2-9.30 mg/kg
7	Zinc	5.70-11.50 mg/kg
8	Sulphur	128-548 mg/kg

Table–1 Common Nutrient Content in Vermicompost

A pictorial representation of the proposed Vermi bed is given below:

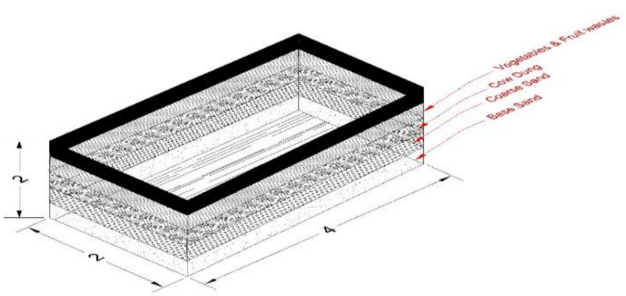

Fig - 3 Proposed Vermibed (In Meters)

4. RESULTS AND DISCUSSIONS

4.1 ANALYSIS OF TEMPERATURE VARIANCE IN VERMI-BED:

The following are the temperature variance for the vermin bed that is employed for observation for over a period of 30 days.

Sl No.	Temperature (°C)
1	5
2	7
3	8
4	5
5	6
6	7
7	8
8	9
9	6
10	8
11	7
12	8
13	9
14	7
15	5
16	7
17	9
18	9
19	9
20	8
21	7
22	8
23	9
24	9
25	9
26	8
27	8
28	8
29	9
30	7

The pattern of the days and temperature variances is given below:

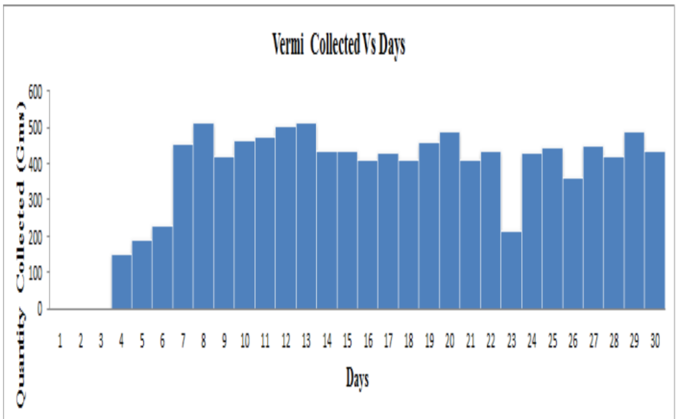

Fig – 4 Temperature Variances Vs Days

The temperature variance here observed was between 5 °C and 10 °C. Hence, it is found to be maintained on the on this desirable temperature limits.

4.2 ANALYSIS AND COLLECTION OF COMPOST IN VERMI-BED:

Following are the collection of compost collected for over 30 days in observation:

Sl No	Vermicompost (gm)
1	0
2	0
3	0
4	150
5	190
6	230
7	456
8	512
9	421
10	465
11	476
12	502
13	512
14	433
15	436
16	411
17	432
18	412
19	457
20	489
21	411
22	435
23	212
24	432
25	444
26	363
27	449
28	421
29	487
30	433

The pattern of the days and amount of manure collected is given below:

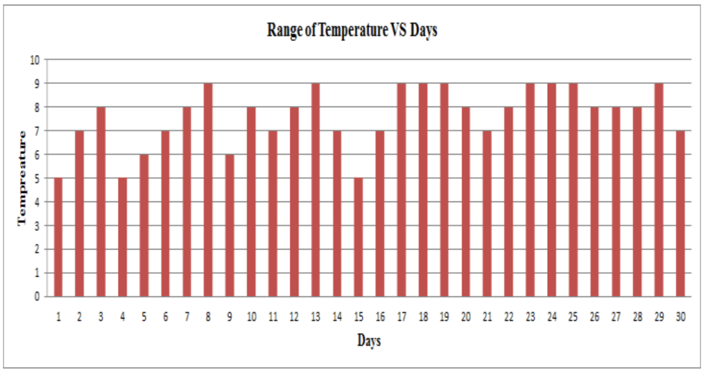

Fig – 5 Temperature Variances Vs Days

From the above observation of about 30 days, a total sum of about 13.258 Kg i.e., a sum of 13258 Grams of pure natural manure was collected.

5.CONCLUSIONS

Different waste treatment options for municipal solid waste have been studied in a systems analysis. Different combinations of incineration, materials recycling of separated plastic and cardboard containers, and biological treatment (anaerobic digestion and composting) of biodegradable waste, were studied and compared to landfilling. The evaluation covered use of energy resources, environmental impact and financial and environmental costs.

The study shows that reduced landfilling in favor of increased recycling of energy and materials lead to lower environmental impact, lower consumption of energy resources, and lower economic costs. Landfilling of energy-rich waste should be avoided as far as possible, partly because of the negative environmental impacts from landfilling, but mainly because of the low recovery of resources when landfilling.

Differences between materials recycling, nutrient recycling and incineration are small but in general recycling of plastic is somewhat better than incineration and biological treatment somewhat worse.

When planning waste management, it is important to know that the choice of waste treatment method affects processes outside the waste management system, such as generation of district heating, electricity, vehicle fuel, plastic, cardboard, and fertiliser.

When solid waste is disposed off on land in open dumps or in improperly designed landfills (e.g. in low lying areas), it causes the following impact on the town.

1) Acidity to surrounding soil and release of greenhouse gas.
2) Bad odor, pests, rodents and wind-blown litter in and around the waste dump.
3) Bird menace above the waste dump and epidemics through stray animals.
4) Erosion and stability problems relating to slopes of the waste dump.
5) Fires within the waste dump and causes serious air pollution in surrounding areas.
6) Generation of inflammable gas (e.g. methane) within the waste dump.
7) Ground water contamination by the leachate generated by the waste dump.
8) Surface water contamination by the run-off from the dumping yard.

ACKNOWLEDGEMENTS

The authors would like to thank the management and department of civil Engineering for extending a great help towards the success of this project. They also want Periyar Maniammai Institute of Science and Technology for providing all the technical details regarding vermi culture and vermicomposting process.

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