A STUDY ON VERMICOMPOSTING OF ORGANIC WASTE AT TIRUPATI

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Abstract : Explosion in population has resulted in enormous increase of Municipal Solid Waste(MSW) generation. Municipal solid wastes can be treated by Reduce, Reuse and Recycle approach. Various methods of composting of MSW such as Indore method, Bangalore method are in vogue. Recently Bio-chest machine has been developed and is being run for composting MSW. However there are certain drawbacks associated with its use such as High initial investment, High power consumption, Requirement of enzyme oil for operation. Vermicomposting is an attractive alternative which has got potential to overcome the above drawbacks. The present study aims to evaluate the feasibility of application of vermicomposting to treat MSW of Tirupati, To compare the qualities of manure obtained from Bio-chest machine and vermicompost in terms of NPKs produced and to evaluate the cost accrued for producing vermicompost. The study was taken up in laboratory scale. Six plastic bins of 10 litre capacity each were taken for vermicomposting of Vegetable waste (VW) was mixed with shreded paper waste(SPW) and slaughter house waste(SHW) in 6 different ratios using earthworm Eisiniafoetida. VW was also found to be favouring compost production upto a maxium VW:SPW:SHW ratio. Comparision of quality and quantity parameters of use of Bio-chest machine and vermicomposting showed that vermicomposting is better. Cost analysis for vermicomposting organic MSW revealed that it takes Rs.1540 to produce a ton of compost which is better than that by Bio-chest machine which takes Rs.1876.

Keywords **- Vermicomposting, Municipal solid waste, Eisiniafoetida, Bio-chest machine.**

I. INTRODUCTION

Majority of Municipal (urban) Solid Waste (MSW) is disposed of in landfills. However, this disposal system is reported to produce hazardous environmental impacts and new policies are initiated to protect the environment from such impacts by discouraging the practice of disposal of solid waste in landfills. Various methods of composting of MSW such as Indore method and Bangalore method are in vogue. Recently Bio-chest machine has been developed and is being run for composting MSW. However, there are certain drawbacks associated with its use such as

i) High initial investment,
ii) High power consumption,
iii) Requirement of enzyme oil for operation and
iv) Large area requirement.

In this context, Vermicomposting is an attractive alternative which has got potential to overcome the above drawbacks. Organic wastes can be converted into valuable wealth by applying vermicomposting technology. Vermicomposting is a simple biotechnological process of composting, in which certain species of earthworms are used to breakdown the organic waste into soil and humus.

II. Composition of Municipal Solid Waste in Tirupati City

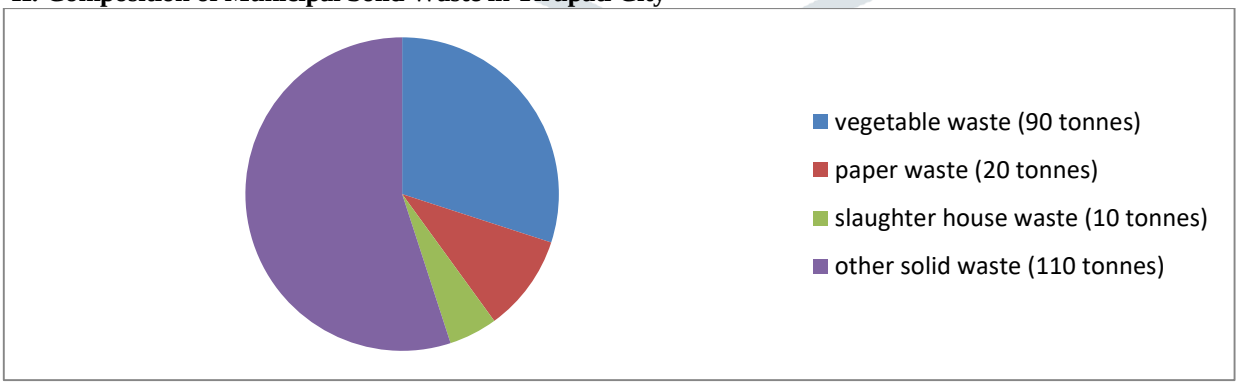

Figure.1 Composition of Municipal Solid Waste in Tirupati City

It can be observed from Fig.1 that organic wastes contribute to about 41% of total wastes. Among the organic wastes the major part is contributed by VW. As, even the minor contribution of 10 tonnes of slaughter house waste is a significant threat to the health and hygiene of the inhabitants of Tirupati. The present study was taken up to curb the same in an optimal manner.

III. EXISTING SOLID WASTE MANAGEMENT SYSTEM IN TIRUPATI CITY

i) Vegetable Waste : Tirupati Municipal Corporation(MCT) has installed two on-site bio-chest compost machines at Indira Priyadarshini Vegetable Market and Rythu Bazar in July,2018. These machines are meant to convert vegetable waste to organic fertilizer.

Table.1 General Information About Bio-Chest Machine (With reference from: MCT, 2018)

S.NO	Particulars	
1	Cost of each machine	Rs 7.9 lakh
2	Capacity of each machine	500 kg per day
3	Cost of enzyme oil used by machine	Rs 8 per day
4	Power consumption	1500 Watt per hour
5	Time period for composting	21 days
6	Compost production	30 % of total weight of waste is converted into compost
7	Cost of compost	Rs 20 per kg

ii) Slaughter House Waste : Slaughter house waste is generally biodegradable, consisting of meat, bones, feathers and skin. This slaughter houses do not follow clean methods of processing meat. The waste from slaughter houses gets mixed with MSW. There is no proper management system for waste generated from slaughter houses in Tirupati city.

iii) Paper Waste : The paper waste is segregated manually by rag-pickers. The kabadiwalas purchase paper waste from residential and commercial establishments while ragpickers collect recyclables from market places, dustbins and dumping sites and sort them before selling off. However, Major proportion of these recyclables are not segregated and subject to Reuse or Recycle and other treatment methods and are simply dumped into landfills.

IV. RESEARCH METHODOLOGY

The study was taken up in laboratory scale. Six plastic bins of 10 litre capacity each were taken for vermicomposting. Vegetable waste was mixed with shreded paper waste and slaughter house waste in 6 different ratios as follows.

Table. 2 Mix Ratios of Waste Materials Used in The Study

Batches	Organic material	Organic Ratio
Batch 1	VW : SPW : SHW	1 : 2 : 1
Batch 2	VW : SPW : SHW	2 : 2 : 1
Batch 3	VW : SPW : SHW	3 : 2 : 1
Batch 4	VW : SPW : SHW	4 : 2 : 1
Batch 5	VW : SPW : SHW	5 : 2 : 1
Batch 6	VW : SPW : SHW	6 : 2 : 1

(VW=Vegetable Waste, SPW=Shreded Paper Waste, SHW=Slaughter House Waste)

Organic waste from market area was transported to the vermicompost project site and cut into small pieces by means of knife. A layer of paper waste of 5 cm thick was bedded into the bin initially to absorb excess water and then topped up with different mixture of wastes as mentioned in Table.1. Organic waste mixture was allowed for initial decomposition for 15 days and turned periodically (once in 5 days) for better aeration. After 15 days 20 gm/kg earth worms were inoculated into each bin and then water was sprinkled on the material at stipulated quantities(50%,60%,70%and80%) and studied for influence of moisture content. The surface of the bins were covered with wooden board to protect earthworms from pits/bins from their enemies like birds, rats, mice, toads, lizards, centipedes, ants and cockroaches etc and water was sprinkled at stipulated quantities every day. pH of samples was measured using systronics pH meter by electrode method. NPKs were measured using standards methods as specified in APHA. UV-VIS spectrophotometer of make Thermoscientific was used to measure phosphorus content. Kjeldah Nitrogen apparatus were used for the determination of nitrogen content in the compost. Flame photometer apparatus were used to determine total potassium content.

V. RESULTS AND DISCUSSION

The nutrient values of Vermicompost obtained in this study with variation in VW ratio at moisture content levels 50%, 60% and 70% after 45 days of composting are presented in Tables. 3,4,5. The overall increase of pH may be attributed to the decomposition of nitrogenous substrates resulting in the production of ammonia (K.Muthukumaravel, 2008). Ammonia which forms a large proportion of the nitrogenous matter was excreted by earthworms. The increased nitrogen may be due to nitrogenous metabolic products of earthworms which are returned to the soil through casts, urine, muco-proteins and earthworm tissue. From the results, it was clear that with gradual increase in VW ratio, the % of NPK in compost also increased. The phosphorous content in the compost is considered to increase due to the mineralization of inorganic phosphate to organic phosphate. The inorganic phosphate is negatively charged and it reacts readily with positively charged metal ions to form relatively insoluble substances thereby fixing the phosphorous in compost. Hence, the phosphorous content is observed to increase in all batches (V.Sudharsan Varma,2015). The potassium content rise during vermicomposting is probably attributed to mineralization by earthworms (R.Rajkumar,2011). The present study supports the work of (K.Muthukumaravel, 2008) who found that the earthworm casts contain more nitrogen, phosphorous and potassium. Hence, on comparision, it can be observed that the resulting NPK's from Vermicomposting are higher than that obtained from Bio-chest machine at moisture contents 60%, 70% and lesser at 50%.At 80% moisture content the composting bin started stinking excessively and the voids got saturated with water. Thus due to non-availability of air, earthworms started moving on to the surface to breathe. So, further experiments at 80% moisture content were abandoned

Table.3 Summary of variation in NPK Values and other parameters with variation in VW ratio at a moisture content of 50%

Batches	Colour	Odour	pH	Moisture content (%)	Total Kjeldah Nitrogen (TKN) (%)	Total Phosphorus (P)(%)	Total Potassium (K)(%)
Batch 1	Black	No Foul Odour	7.02	48.4	0.26	1.58	0.51
Batch 2	Black	No Foul Odour	7.13	48.56	0.34	1.75	0.66
Batch 3	Black	No Foul Odour	7.25	48.59	0.46	1.92	0.74
Batch 4	Black	No Foul Odour	7.32	48.62	0.53	2.14	0.87
Batch 5	Black	No Foul Odour	7.47	48.65	0.67	2.34	0.95
Batch 6	Black	No Foul Odour	7.54	48.68	0.78	2.56	1.07
Bio-chest Compost	Black	No Foul Odour	7.6	-	0.81	2.61	1.09
Standard values (ICAR)	Dark brown-Black	No Foul Odour	6-8	-	0.50-1.50%	0.10-3.00%	0.15-1.50%

Table.4 Summary of variation in NPK Values and other parameters with variation in VW ratio at a moisture content of 60%

Batches	Colour	Odour	pH	Moisture content (%)	Total Kjeldah Nitrogen (TKN) (%)	Total Phosphorus (P)(%)	Total Potassium (K)(%)
Batch 1	Black	No Foul Odour	7.10	58.3	0.32	1.69	0.61
Batch 2	Black	No Foul Odour	7.24	58.5	0.44	1.83	0.73
Batch 3	Black	No Foul Odour	7.33	58.9	0.54	2.01	0.82
Batch 4	Black	No Foul Odour	7.42	59	0.67	2.24	0.95
Batch 5	Black	No Foul Odour	7.53	59.3	0.78	2.48	1.07
Batch 6	Black	No Foul Odour	7.65	59.8	0.86	2.64	1.14
Bio-chest Compost	Black	No Foul Odour	7.6	_	0.81	2.61	1.09
Standard values (ICAR)	Dark brown-Black	No Foul Odour	6-8	_	0.50-1.50%	0.10-3.00%	0.15-1.50%

Table.5 Summary of variation in NPK Values and other parameters with variation in VW ratio at a moisture content of 70%

Batches	Colour	Odour	pH	Moisture content (%)	Total Kjeldah Nitrogen (TKN) (%)	Total Phosphorus (P)(%)	Total Potassium (K)(%)
Batch 1	Black	No Foul Odour	7.35	67.4	0.52	1.85	0.86
Batch 2	Black	No Foul Odour	7.46	67.9	0.68	2.08	0.92
Batch 3	Black	No Foul Odour	7.59	67.1	0.7	2.24	1.04
Batch 4	Black	No Foul Odour	7.71	68.4	0.89	2.46	1.12
Batch 5	Black	No Foul Odour	7.84	68.2	0.91	2.69	1.26
Batch 6	Black	No Foul Odour	7.97	68.7	1.24	2.86	1.38
Bio-chest Compost	Black	No Foul Odour	7.6	_	0.81	2.61	1.09
Standard values (ICAR)	Dark brown-Black	No Foul Odour	6-8	_	0.50-1.50%	0.10-3.00%	0.15-1.50%

Table. 6 Cost to treat Organic Waste by Vermicompost Process (Present Study)

Sl.no	Particulars	Cost of each quantity	No of quantities	Cost in INR
1	Plastin bin	Rs.20	6	Rs.120
2	Cost of Earthworms used for kg of waste	Rs.0.5	45 kg	Rs.22.5
3	Watering	Rs.0.1	31.5	Rs.3.15
4	knife	Rs.10	1	Rs.10
5	Hand gloves & mask set	Rs.20	1	Rs.20
6	Total cost to treat 45 kgs of waste			Rs.175.65
7	**Total cost to treat 1 kg of waste**			Rs.3.9

Table. 6 Lists the particulars of various materials used in the vermicompost process in the present study, cost of each quantity, no of quantities used in the process and the total cost to treat 1 kg of organic MSW. In present study, compost weighing 50% of total weight of organic waste was produced by vermicomposting process.

Table. 7 Comparision of cost of production of compost by vermicomposting process and Bio-chest machine (Rs. / ton)

Sl no	Vermicomposting process (Present study)				Bio-chest machine (Reference : MCT)			
	Particulars	**Cost of each quantit-y**	**No of quantit-ies**	**cost in INR**	**Particulars**	**Cost of each quantit-y**	**No of quantit-ies**	**cost in INR**
1	**Material Costs:** Earthworms Watering	 Rs.0.5 Rs.0.1	 2000 1400	 Rs.1000 Rs.140	**Material Costs:** Enzyme oil	 Rs.8	 7	 Rs.56
2	**Labour Costs:** Waste collection Filling of pits Separation of worms Watering	Rs.200	2	Rs.400	**Labour Costs:** Waste collection Filling of machine	Rs.200	7	Rs.1400
3	–	–	–	–	**Electricity bill**	Rs.420	1	Rs.420
4	**Total production Cost (Rs / ton)**			Rs.1540	**Total production cost (Rs / ton)**			Rs.1876
5	**Capital cost (Rs/ton)** Land Shed Tools & Equipment			Rs.5000	**Capital cost(Rs /ton)** Land Shed Machinery Tools & Equipment			Rs.253333

Table. 7 shows the camparison of cost of production of compost by vermicomposting process and Bio-chest machine. Cost analysis for vermicomposting organic MSW revealed that it takes Rs.1540 to produce a ton of compost which is better than that by Bio-chest machine which takes Rs.1876. It is evident from the study that cost of production and capital cost of vermicomposting process is reasonable compared to Bio-chest machine.

VI. CONCLUDING REMARKS

1. It was observed that increase in moisture content and VW ratio increased pH value to a maximum of 8
2. Increase in moisture content (from 50% to 70%) increased the quantities of NPKs.
3. However moisture content above 70% (i.e 80%) was detrimental to the survival of earthworms due to saturation of voids and subsequent non-availability of air.
4. VW was also found to be favouring compost production upto a maxium VW: SPW: SHW ratio of 6:2:1.
5. Comparision of quality and quantity parameters of use of Bio-chest machine and vermicomposting showed that vermicomposting is better .
6. Cost analysis for vermicomposting organic MSW revealed that it takes Rs.1540 to produce a ton of compost which is better than that by Bio-chest machine (Rs.1876).

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