

Composting of Municipal Solid Waste of Jabalpur City

¹S.P. Gautam, ²P.S. Bundela, ³A.K. Pandey, ²M.K. Awasthi and ³S. Sarsaiya

¹Central Pollution Control Board, New Delhi, India

²Regional Office M.P. Pollution Control Board, Vijay Nagar Jabalpur (M.P.), India

³ Department of Biological Sciences, Mycological Research Laboratories, R.D.
University, Jabalpur (M.P.), India, 482001

Abstract: A pilot study was conducted to assess the feasibility of composting of source separated organic matter of municipal solid waste (MSW) generated in low, middle and high income areas of Jabalpur city with a population over 5 lakh. Results of MSW analysis indicate the presence of high percentage of Biodegradable organic matter, acceptable moisture content and C/N ratio. On windrow composting, not only the volume of the waste was reduced but also produced a crumbly earthy smelling soil-like, compost material. All quality parameters in the compost samples were found to be within the acceptable limits set by international standard. The pH ranged between 7.8-8.1, organic matter 45%, moisture 36% and have acceptable amount of plant nutrients C35%, N (0.05%), P (0.002), Na (4.8%), K (0.35%). The compost quality could further be improved by adding cow manure, poultry manure or yard waste etc. Its use in plant production or land reclamation may be helpful to maintain soil fertility and improve moisture holding capacity. MSW Composting could be adapted country wide to recycle/reuse the organic residue as solid waste management option.

Key words: Municipal solid waste (MSW) • Composting • Recycle

INTRODUCTION

Rapid increase in population and change in life style in India have resulted in a dramatic increase in (MSW). MSW includes both domestic and commercial waste account for a relatively small part of the total solid waste stream in developed countries [1]. Accumulation of a large amount of waste may create several problems to inhabiting populations. It requires application of some effective strategies for proper disposal of (MSW). Composting is a microbial based aerobic process which is now consider as an environmentally sound way to reduce organic waste and produce organic fertilizer or soil conditioner [2]. Modeling composting process is the prerequisite to realize the process control of composting. Over past years, there have been many approaches [3]. which have been used to investigate composting processes [4-6] considered growth rates of microorganisms and used the mooned equation to simulate the composting processes [7-9] made emphasis on the thermodynamic and physicochemical changes taking place during composting processes [10,11] developed a dynamic simulation model to present biodegradation processes in composting based on the knowledge of the physical and chemical change occurring

in the processes [12,13] also conducted a number of workers on the modeling for composting process. The MSW composting is being encouraged in many countries of the world and researchers have experienced the benefits of using MSW compost in the field [14-17].

Keeping in view the quantum of MSW generation in Jabalpur city and huge cost for its disposal, the present investigation was carried out to select an appropriate system of solid waste management which is discussed in this paper.

MATERIALS AND METHODS

The investigation was conducted at Madhya Pradesh Pollution control Board Vijay Nagar Jabalpur and Mycological Research laboratory R.D.V.V. Jabalpur Campus in the month of March to May 2009 at ambient temperature ranging from 35 to 45 °C. MSW were collected from nine different localities from Jabalpur city, representing high, middle and low socio economic areas. The organic material mainly vegetable, fruit and kitchen waste etc., were separated manually and subjected to turned windrows composting process. Percentage of organic waste generated at various income groups were determine as per [18].

The total weight of introduced organic material for composting and the finished compost were calculated by weighing. Required operation conditions of composting were maintained as per [19]. Aeration typically in the heap was provided by manually turning of waste. A heap of manually separated mixed MSW of 4' high, 8' long was placed on paved ground on composting windrow type and was watered regularly to maintain moisture level between 50- 60% and turned manually every 3-5 days for the first six weeks of composting cycle. From the seventh week, the moisture was allowed to drop when optimum biosolids decomposition was achieved. The process was completed in about 8-9 weeks. After this period the compost was allowed to cure for additional three weeks without turning. The finished compost was then screened out and weighed. A representative compost sample was taken from the homogenized compost heap for the sequential physicochemical analyses. Sub-samples (250 g) were taken from 4 different points of the compost heap (bottom, surface, side and centre).the following physical parameters pH, Electrical conductivity, was determined on a sample in water (1:5), the Organic carbon (TOC) was determined by TOC analyzer, Phosphorus was analyzed by spectrophotometer and the Concentration of Sodium and Potassium in the sample were measured using flame photometer. Total Kjeldahl Nitrogen (TKN) was estimated by [20].

RESULTS AND DISCUSSION

Presence of significant amount of biodegradable organic and inorganic materials in comparison of those of standard value [22]. as shown in Table 1 and 2.

clearly indicate that the organic fraction of the refuse was highly suitable for composting process. Similar observations have also made by many earlier workers [23, 24,]. It was observed during the process that the mixture heated up rapidly, reaching a temperature of 48°C after one day of composting. By maintaining the temperature of 48 – 50 °C for initial 3 days of the process, the frequency of turning and mixing of the waste was increased to obtain temperature between 35- 40 °C, (an optimum level for microbial degradation) [25-27]. During the course of present investigation, it was observed that the reduction in weight of waste was more significantly in the first week. It may be done to maximum microbial activity during this period. Composting of MSW during summer season required 4-8 weeks where more than 70% weight loss was recorded, earthy smell of the material after one week clearly indicated the maturity of compost [19, 28]. It was noted that the weight loss gradually become more pronounced during first week of the test, as microbial activity increased to maximum. It was observed that, the composting process in summer season was completed in about 4-6 weeks. The weight reduction in summer season it was above 70% similar finding observed by [29]. The screened compost samples were drawn and analyzed in the laboratory for the parameters such as pH, Organic matter and moisture. Data recorded in Table 3 and 4. clearly indicates that the test sample were at part with prescribed international standard of quality of compost. Organic matter was significantly high (39-47%) while carbon, nitrogen ratio and pH values more or less lies at part with standard. Comparatively low nitrogen content was recorded. The amount of other plant nutrients viz. phosphorus (0.42-0.85%),

Table 1: Composting of municipal solid waste in high, middle and low socioeconomic localities

S.No.	Components	High%(by weight)	Middle	Low
1.	Paper	9	6	4
2.	Plastic / Polythenes	14	17	21.4
3.	Textile	1.5	3	2
4.	Rubber/ Leather	1	2	1.2
5.	Metal	0.8	0.5	0.3
6.	Glass	3.2	4.2	1.3
7.	Food wastes	30.2	28.5	24.4
8.	Soil	38.5	37.3	42.2
9.	Miscellaneous	1.8	1.5	3.2

Table 2: Average chemical composition of municipal solid waste

S.No.	Parameters	Average values	*Standard values suitable for composting
1.	pH	7.80	5.5-8.0
2.	Moisture (%dry basis)	36	<50
3.	Organic matter (%dry basis)	45	>20
4.	Nitrogen (%dry basis)	0.05	>0.6
5.	Carbon (%dry basis)	32	30-40
6.	C/N ratio (total dry basis)	40:1	25-50:1
7.	Phosphorus	0.002	No specs
8.	Sodium	4.8	No specs
9.	Potassium	0.35	No specs

(*Source: Standard Zucconin, F. and deBertolidi, M., 1987) [21]

Table 3: Comparative average values of pH, Organic matter (%dry basis) and moisture content of MSW Compost and Chemical fertilizer samples

S.No.	Sample type	pH	Organic matter (%dry basis)	Moisture
1.	MSW Compost (High income)	7.75±0.32	39±1.4	34
2.	MSW Compost (Middle income)	7.82±0.27	47±1.21	41
3.	MSW Compost (Low income)	7.84±0.52	44±1.5	25
4.	Chemical fertilizer	6.95±0.11	38±0.71	00

Table 4: Comparative average nutritional values and C/N ratio of composts and Chemical fertilizer samples

S.No.	Sample type	C(%dry basis)	N(%dry basis)	C/N ratio(Total dry basis)	P	K	Na
1.	MSW Compost (High income)	35	0.05	35:0.05	0.003	0.36	3.4
2.	MSW Compost (Middle income)	37	0.03	37:0.03	0.005	0.34	4.6
3.	MSW Compost (Low income)	32	0.07	32:0.07	0.002	0.32	4.3
4.	Chemical fertilizer	22.00±0.71	0.86±0.09	25:58	0.75±0.21	0.18±0.02	0.25±0.02
5.	MSW Compost Quality Standard	>25	>1	<25	No Specs	NoSpecs	NoSpecs

Sodium (1.21-1.92%) and Potassium (1.00-1.80%) were also found within the acceptable limits as prescribed for soil conditioning similar observation have also made by several other workers [30-32].

The nitrogen deficiency could be improved by addition of phosphoric acid which also prevents excessive volatilization of ammonia [33].

The standard excellent quality compost, generally contain high concentration of nitrogen but no specific value set for Phosphorus or Potassium while the MSW compost prepared during the present study was found to be as good soil conditioner and ecofriendly cheap and best as compare to Chemical fertilizer. Therefore, its use in Jabalpur soil may add compost and improve the aeration, aggregation and water holding capacity use helps to prevent erosion, supplies slow release of nutrients and can control numerous soil born disease.

CONCLUSION

Based on the study it can be concluded that municipal solid waste is suitable for composting because of the presence of high percentage of biodegradable organic matter, acceptable moisture content and C/N ration in the waste. However, the composting process and compost quality could further be improved by adding inoculating agent like cow manure, poultry manure, yard waste etc. in the municipal solid waste. Since Jabalpur soil is sandy, erodible, low water holding capacity with little organic matter and nutrient content, the application of compost would be an investment in the long term for the health of soils and plants. Finally, it is concluded that a module of this type for the recovery of valuable and economical organic fertilizer- the compost, can be adapted country wide to recycle the organic residues as waste management option.

ACKNOWLEDGEMENTS

The authors are thankful to Madhya Pradesh M.P. Pollution Control Board Bhopal and Head, Department of Biological Sciences, R.D. University, Jabalpur, for laboratory facilities. Also thanks to Municipal Corporation of Jabalpur for his support. Ministry of Environment and Forest New Delhi is also thankfully acknowledged for financial support.

REFERENCES

- White, P.R., M. Franke and P. Hindle, 1995. Integrated solid waste management: A lifecycle Inventory, Chapman and hall, London.
- Gajdos, R., 1992. The use of Organic waste materials as organic fertilizer- recycling of plant nutrients. Acta Hort., 302: 325-331.
- Miller, F., 1996. Composting of municipal solid waste and its components. Microbiology of solid waste. CRC Press, pp: 116-45.
- Hammeleres, H.A., 1993. Theoretical Model of Composting Kinetics. Science and Engineering of Composting. The Ohio State University, pp: 37-58.
- Stombaugh, D.P. and S.E. Nokes, 1996. Development of a Biologically Based Aerobic Composting Simulation Model. Transactions of ASAE, 39(1): 239-50.
- Agamuthu, P., 2000. Kinetic Evaluation of Composting of Agricultural Wastes. Environ. Technol., 21(1): 185-92.
- Keener, H., C. Marugg, R.C. Hansen, H. Hotink, 1993. Optimizing the Efficiency of the Composting processes. Science and Engineering of Composting. The Ohio State University, pp: 59-94.

8. Haug, R.T., 1993. Development of Simulation Models, In: *The Practical Handbook of Compost Engineering*, Lewis Publishers, pp: 385-436.
9. Ahmed, M., A. Idris and S.R. Syedomar, 2007. Physicochemical Characterization of Compost of the industrial Tannery Sludge. *J. Engineering Sci. Technol.*, 2: 81-94.
10. Mohee, R. and R.K. White, 1998. Simulation Model for Composting Cellulosic (Bagasse) Substrates. *Compost science and Utilization*, 6(2): 82-92.
11. Gazi, A.V., A. Kyriacou, M. Kotsou and K.E. Lasaridi, 2007. Microbial Community Dynamics and Stability Assessment during Green Waste Composting, 9(1): 35-41.
12. Hamoda, M.F., H.A. Abu and J. Newham, 1998. Evolution of municipal solid waste composting kinetics. *Resources, Conservation and Recycling*, 23(1): 209-23.
13. Wang, H.T. and Y.S. Li, 2001. Simulation model of dynamic aerobic compost and the application. *China Environ. Sci.*, 21(3): 240-4.
14. Porkhrel, D. and T. Viraraghavan, 2005. Municipal solid waste management in Nepal: practices and challenges. *Waste Manag.*, 25(5): 555-62.
15. Abigail, A.M., 1998. Using municipal solid waste compost in nursery stock production. *Bio. Cycle. J.*, 39(5): 63-65.
16. John, H., 1997. Apply compost and mulches to control erosion. *Bio. Cycle. J.* 38(5): 63-65.
17. Barth, J. and B. Kroeger, 1998. Composting progress in Europe. *Biocycle*, pp: 65-68.
18. Jilani, S., 2007. Municipal solid waste composting and its Assessment for reuse in plant production. *Pak. J. Bot.*, 39(1): 271-277.
19. Haug, H.B., 1980. Composting-sanitary Disposal and Reclamation of solid waste. WHO Geneva.
20. Jackson, M.L., 1967. *Soil Chemical analysis*. Prentice-Hill of India Pvt. Ltd., New Delhi.
21. Zuccconi, F. and M. de. Bertoldi, 1987. Compost specification for the production and characterization of compost from municipal solid waste, In: *Compost production, quality and the use*, (Eds.): M.De. Bertoldi, M.P. Ferranti, P.L., Hermite and F. Zuccconi, Elsevier Applied Science Publishing Co.,Inc., New York.
22. Anon, J.M., 1987. Composting of organic waste. *Bio. Cycle. J.*, 59(2): 235-239.
23. Flintoff, F., 1976. Management of Solid waste in developing countries. WHO regional publication of south East Asia. Serial No.1. WHO, New Delhi.
24. Khatib, R., N.F. Usmani and S.S. Husain, 1990. Evaluation of recycling material in municipal solid waste from Karachi. *Bio. Wastes*, 31: 113-22.
25. Babyranidevi, S. and R.V. Bhojar, 2003. Feasibility of some treatment for improving the composting of municipal solid waste. *Indian J. Environ. Health*, 45(3): 231-4.
26. Xi, B., W. Meng, G. Huang, H. Liu, G. Zeng, X. Yuan, Q. Wang and Q. Bai, 2003. Composting technology of municipal solid waste with inoculating agent. *Huan Jing Xue.*, 24(1): 157-60.
27. Technobanoglous, G., H. Theisen and S.A. Vigil, 1993. *Integrated solid waste Management: Engineering Principles and management Issues*. New York. McGraw Hill. International Editions.
28. Gotaas, H.B., 1956. *Composting- Sanitary Disposal and Reclamation of solid waste*. WHO. Geneva.
29. Andrea, C., S. Salvia and Z. Gianni, 1998. Efficiency of Backyard Composting. *Bio. Cycle. J.*, 39(6): 76-78.
30. Paul, V.W. and O.S. Jessie, 1997. Measuring process parameters at an enclosed composting facility. *BioCycle. J.*, 38: 58-61.
31. Saidi, N., M. Cherif, N. Jedidi, M. Fumio, A. Boudabous and A. Hassen, 2008. Evolution of Biochemical parameters during Composting of various waste compost. *African J. Environ. Sci.*, 4(4): 332-341.
32. Taiwo, L.B. and B.A. Oso, 2004. Influence of composting techniques on microbial succession, temperature and pH in a composting municipal solid waste. *African J. Biotechnol.*, 3(4): 239-243.
33. Dinel, H., T. Marche, M. Schnitzer, T. Pre and P. Champagne, 2004. Co composting of papers mill sludge and hardwood sawdust under two types of in-vessel processes. *J. Environmental Science and Health. PartB- pesticides, Food Contaminants and Agriculture Waste*, 39(1b): 139-151.

Composting of Municipal Solid Waste of Jabalpur City. 1. S.P. Gautam, 2P.S. Keeping in view the quantum of MSW generation in Jabalpur city and huge cost for its disposal, the present investigation was carried out to select an appropriate system of solid waste management which is discussed in this paper. Rapid increase in population and change in life style. in India have resulted in a dramatic increase in (MSW). MSW includes both domestic and commercial waste account for a relatively small part of the total solid waste stream in developed countries [1]. Accumulation of a large amount of waste may create several problems to inhabiting populations. It requires application of some effective strategies for proper disposal of (MSW). Downloading: Managing municipal solid waste.pdf PDF document, 5.30 MB (5555755 bytes). More Information. Less Information. Together, these instruments establish a range of waste management targets and broader goals for the years to 2020. Download. Managing municipal solid waste.pdf [5.3 MB]. See additional files. Order information. Municipal solid wastes were collected from different waste dumping points of Jabalpur in polythene bags. Samples were cut into small pieces, and 5 g of each was aliquoted into petri plates, which were then wrapped by using polythene bags. The plates containing municipal solid waste were then autoclaved at 121°C for 15 min, and 25 kg of waste in polythene bags was also autoclaved for preparing piles. After sterilization, the inoculum was inoculated in a petri plate and piles in triplicate. Municipal solid waste is suitable for composting because of the presence of high percentages of organic matter. The *T. viride* had promising effects in the decomposition of organic municipal solid waste, resulting in a greater bioconversion of the original material than the control.