STUDIES AND INVESTIGATION ON VERMICOMPOSTING

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Abstract

Vermicomposting is one of the most practiced methods for domestic and household solid waste. Vermicomposting consists of segregation of waste, precomposting, postcomposting and Earthworms addition. In the present investigation performance of an existing vermicomposting plant is analyzed. During performance evaluation of vermicomposting plant, the changes in bio-physiochemical parameters were computed. The vermicomposting process requires a moisture content of 30 to 50%. There was visible effect of vermicomposting on the losses of organic content. Also the percentage of organic content decreased during the period of vermicomposting. This implies that the decomposition of waste by worms population. There was decrease in the pH during vermicomposting. The process is most effective between pH ranges 6.4 to 7.6.

Keywords: *Moisture Content, Organic Content, pH, Temperature, Composting, Stabilization.*

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1. INTRODUCTION

The solid waste treatment is major concern in modern civilization. Various solid waste treatment techniques are being explored. Some of the domestic waste can be used for synthesis of various compounds like ethanol [1-5]. The production of biogas is advantage in anaerobic treatment [6-8]. Aerobic digestion methods are also frequently used for waste stabilization [9,10]. Municipal solid waste consists of recyclable substances, compostable organic matter, fruit and food waste, dust and other inert matters. Poorly maintained transportation facilities and landfill sites poses major problem for solid waste disposal and human health. Air gets polluted due to open dumping. At least 50-55 percent municipal solid waste contains valuable resources for fertilizers and organic compounds. 35-40 percent municipal waste is biodegradable. Vermicomposting is one of the most practiced methods for domestic and household solid waste. Vermicomposting consists of segregation of waste, precomposting, postcomposting and Earthworms addition. In the present investigation performance of an existing vermicomposting plant is analyzed.

2. LITERATURE REVIEW

Investigation on biodegradable residential solid waste for vermicomposting was carried out by Sequeira and Chandrasekhar [11]. The waste food was divided as food waste, paper waste, vegetable waste and garden trimmings with grass and leaves by them. They found that even dilute cow dung slurry is sufficient to practice vermicomposting in a small scale. Chan et.al. investigated greenhouse gas (GHG) emissions from three different home waste treatment methods. Aerobic composting, anaerobic digestion and vermicomposting methods were used by them[12].They found that aerobic composting bins released lower amounts of CH_4. Their studies showed that home composting had potential for reducing GHG emissions. In their investigation, Suthar and Singh found that maximum mineralization and decomposition rate in experimental container was with P. sansibaricu than that of P. excavates[13].Nagavallemma et.al. were able to improve the water holding capacity and nutrient supplying capacity of soil by amending with good quality organic soil additives[14].According to Aalok et.al., vermicomposting may provide an opportunity for employmentin unprivileged areas[15]. Albasha et.al.treated kitchen waste with vermicomposting[16].Possibility of use of vermicomposting leachate as organic foliar fertilizer and nutrient solution in hydroponic culture was examined by Quaik et.al.[17].Vermicomposting and inorganic fertilizers affected vegetative growth and fruit production for tomato according to Kashem et.al.[18].According to their investigation, there is considerable effect on factors like shoot length, number of leaves, dry matter weight of shoots and roots, fruit number and fruit weight after the application of vermicompost. Evaluation of the effectiveness of different precomposting periods on the sanitization and vermi-composting of dairy manure–waste paper mixtures was carried out by Mupondi et.a.[19].They were able to eliminate 95% of fecal coliforms, Escherichia coli and of E. coli 0157. Ndegwa and Thompson, in their investigation found that different earthworm species impact differently by C-to-N ratio and feed mixture type[20].

3. AIM AND OBJECTIVE

The work is carried out to check the suitability of vermicomposting for handling biodegradable waste generated in urban areas. The parameters like moisture content, organic content, pH and temperature were studied

4. PERFORMANCE EVALUATION OF VERMICOMPOSTING PLANT

Performance evaluation of plat near educational complex in Maharashtra was carried out. The waste contains flowers, leaves, papers, threats, food waste, cotton, plastic bags. Process of vermicomposting was carried out in following steps-a. Segregation b. Precomposting, v. Bed preparation

for Vermicomposting, d. Water Spraying e. Final compost bed removal f. Sieving of compost for separate worms, g. Preservation of worms at cool and moist condition with proper food up to next bed preparation h. Storage of compost at dry place. Density of raw waste was 350 kg/m^3, organic content was 55 percent, moisture content- 28percent and phosphorus content was 6 percent. Pre-composting of raw waste was carried out to increase pH. Moisture content was maintained more than 30 %. Pre-composting was done open to atmosphere in stretch. Water was sprinkled on bed every day. Some problems such as odor and breeding of pathogen vectors such as flies, mosquitoes were encountered as pre-composting stretch was open to atmosphere. Density, organic content, moisture content and phosphorus content of pre-composted waste were 290 kg/m^3, 50 percent, 34percent and 7.1 percent respectively. During performance evaluation of vermicomposting plant, the changes in bio-physiochemical parameters were computed and are described below.

5. RESULTS AND DISCUSSION

Vermicomposting includes coupled activities of earthworms and microorganisms, stabilizing the organic matter and does not involve a thermophilic phase. For evaluating performance of existing vermicomposting plant following parameters were analyzed by standard methods: moisture content, organic content, temperature, pH. Vermicomposting on pre-compost was carried for 45 days.

5.1. Variation in pH with Time

The process is most effective between pH ranges 6.4 to 7.6. As shown in fig.1, a slow decrease in pH was observed during vermicomposting. The action of microorganisms on carbohydrates and subsequent release of organic acids may be the reason behind initial drop in pH. Further, worm stabilization of nitrogen causes rise in pH due to production of ammonia. Finally the pH becomes neutral until the end of vermicomposting process. Utilization of organic acids and increase in mineral constituents of waste is predicted reason for this. A pH level below 6 can slow decomposition, and a pH level above 8 can cause the release of unpleasant smelling ammonia. Insufficient oxygen may be the cause of low pH. Increasing the aeration by turning the pile should raise the pH. As per graph, pH value is fluctuating up to the period of 31 to 35 days but after 35 days pH remains constant at value 7.0.

5.2. Variation in Moisture Content with Time

The vermicomposting process needs a moisture content of 30 to 50%.The low percentage of moisture limits biodegradation. At higher percentage, the water displaces much of the air in the pore of composting bed leading to anaerobic condition. As shown in fig.2, observed moisture content was maintained between 30 to 45%. The heat generated by biological metabolism causes evaporation, consequently decreasing the moisture content.

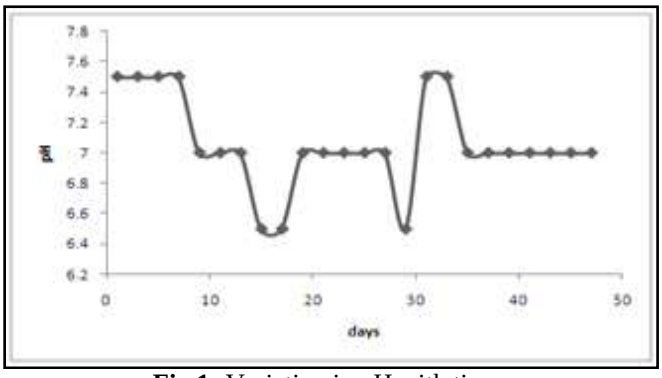

Fig.1: Variation in pH with time

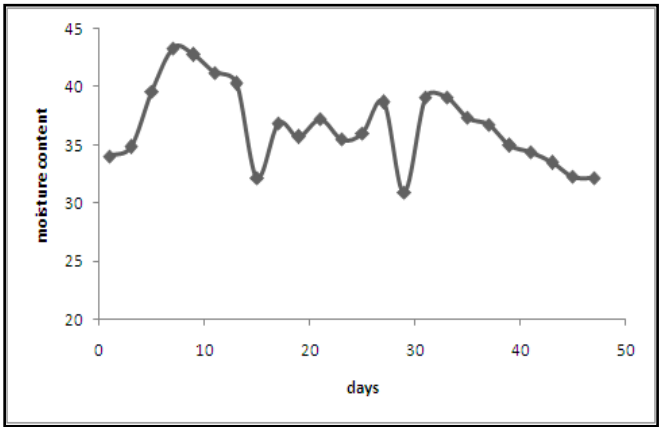

Fig.2: Variation in moisture content with time

5.3. Variation in Organic Content with Time

Variation in organic content with time is shown in fig. 3. Vermicomposting affected the losses of organic content significantly. It was observed that there was decrease in the percentage of organic content during the period of vermicomposting. It indicates the decomposition of waste by verms population. Thus over the course of the vermicomposting the concentration of organic content declined from 49 % to 38. The reduction in carbon could be achieved either by the respiratory activity of earthworms and microorganisms or by increase in nitrogen by microbial mineralization of organic matter in combination with addition of the worms.

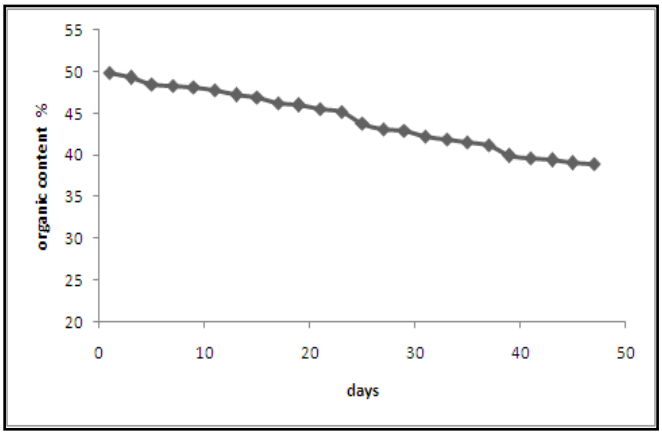

Fig.3: Variation in organic content with time

5.4. Variation in Temperature with Time

Fig.4 and 5 depicts variation in temperature with time. It can be seen that temperature range between 25 to 35 ^{0}C is good for growth and survive of worms. For many varieties of earth worms, temperature above 35°C has been reported to be lethal. The difference of bed temperature and ambient temperature with respect to time is presented in fig.5. It can be seen that temperature of bed was initially higher than the ambient temperature. The bed temperature goes on reducing until 30 days. However, from the17th day, the ambient temperature was observed to be below the bed temperature. The maximum increase in the temperature above ambient temperature was 3.20^{o}C. Sprinkling of water for maintenance of 40 % moisture level may have caused fall in temperature. Enhanced microbial action after lag phase causes increase in temperature after 30 days due to easily available simple from of nutrients.

6. CONCLUSION

The process is most effective between pH ranges 6.4 to 7.6. There was decrease in the pH during vermicomposting. This indicates the action of microorganisms on carbohydrates which releases organic acids. Consequently, worms stabilizes nitrogen and brings about increase in pH due to production of ammonia. Finally the pH becomes neutral until the end of vermicomposting process. The vermicomposting process requires a moisture content of 30 to 50%. There was visible effect of vermicomposting on the losses of organic content. Also the percentage of organic content decreased during the period of vermicomposting. This implies that the decomposition of waste by worms population. In the present studies temperature was observed within the optimum limit of 25 to 30^{o}C.

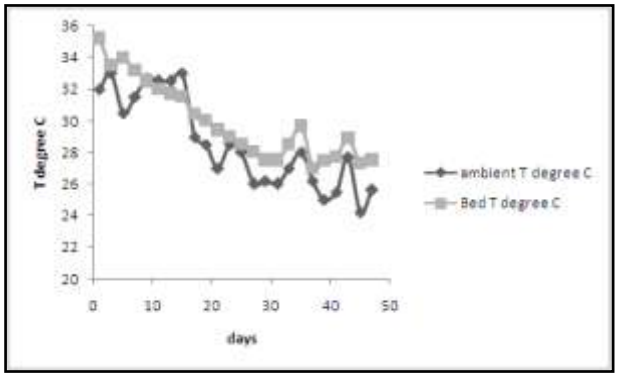

Fig.4: Variation in temperature with time

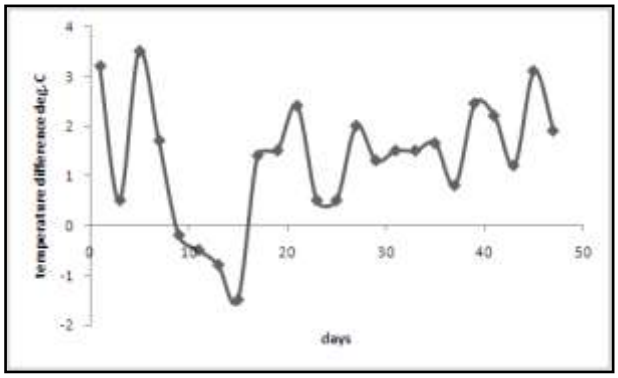

Fig.5: Variation in temperature difference with time

REFERENCES

[1] Harish Kumar Reddy Y., Srijana M., Madhusudhan Reddy D. and Gopal Reddy, "Coculture fermentation of banana agrowaste to ethanol by cellulolytic thermophilic Clostridium thermocellum CT2", *African Journal of Biotechnology*, vol. 9, no.13, pp. 1926-1934, 29 March, 2010.

[2] Masoud Vazirzadeh, Reza Robati, "Investigation of bio-ethanol Production from Waste Potatoes ",*Annals of Biological Research*, vol.4,no.1, pp.104-106,2013.

[3] Sunil J. Kulkarni, Nilesh L. Shinde, Ajaygiri K. Goswami, "A Review on Ethanol Production from Agricultural Waste Raw Material", *International Journal of Scientific Research in Science, Engineering and Technology*, vol. 1, no. 4, pp.231-233, 2015.

[4] R. Arumugam, M.Manikandan, "Fermentation Of Pretreated Hydrolyzates Of Banana And Mango Fruit Wastes For Ethanol Production",*Asian J. Exp. Biol. Sci*., vol.2, no.2, pp. 246-256, 2011.

[5] Sunil Jayant Kulkarni, "Food Waste Utilization: An Insight into Research and Studies", *International Journal of Ethics in Engineering and Management Education*, vol.3, no.8, pp.1-4, 2016.

[6] Nickolas J. Themelis, "Material And Energy Balances In A Large-Scale Aerobic Bioconversion Cell",*Waste Management And Research*, vol.20, 234-242, 2002.

[7] N.H.S.Ray, M.K.Mohanty, R.C.Mohanty, "Anaerobic Digestion of Kitchen Wastes:"Biogas Production and Pretreatment of Wastes, A Review", *International Journal of Scientific and Research Publications*, vol.3, no.11, pp.1-6, 2013.

[8] Rebecca Sebola, Habtom Tesfagiorgis, and Edison Muzenda, "Productionof Biogasthrough Anaerobic Digestion of various Waste: Review", Intl' Conf. on Chemical, *Integrated Waste Management and Environmental Engineering (ICCIWEE'2014*), April 15-16, Johannesburg, pp. 196-205, 2014.

[9] AR Mesdaghinia, M Panahi Akhavan, F Vaezi, K Naddafi, GH Moosavi, "Waste Sludge Characteristics of a Wastewater Treatment Plant Compared with Environmental Standards", *Iranian J Publ Health*, vol. 33, no. 1, pp.5-9, 2004.

[10] Claudia Bruna Rizzardini and Daniele Goi, "Sustainability of Domestic Sewage Sludge Disposal", *Sustainability*,vol.6,pp.2424-2434,2014.

[11] Vincent Sequeira and J.S. Chandrashekar, "Vermicomposting of Biodegradable Municipal Solid Waste Using Indigenous Eudrilus Sp. Earthworms", *Int.J. Curr.Microbiol. App.Sci*., vol.4, no.4, pp.356-365, 2015.

[12] Yiu C Chan, Rajiv K Sinha and Weijin Wang, "Emission of greenhouse gases from home aerobic composting, anaerobic digestion and vermicomposting of household wastes in Brisbane (Australia)", *Waste Management and Research*, vol.29, no.5, pp.540-548, 2010.

[13] S. Suthar, S. Singh, "Vermicomposting of domestic waste by using two epigeic earthworms (Perionyx excavatus and Perionyx sansibaricus)", *Int. J. Environ. Sci. Tech*., vol.5, no.1, pp.99-106.

[14] Nagavallemma K P, Wani S P, Stephane Lacroix, Padmaja V V, Vineela C, Babu Rao M and Sahrawat K L, "Vermicomposting: Recycling wastes into valuable organic fertilizer. Global Theme on Agrecosystems", *Report no. 8., Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics*., pp.1-20, 2014.

[15] Asha Aalok, A.K. Tripathi and P. Soni, "Vermicomposting: A Better Option for Organic Solid Waste Management", *J. Hum. Ecol*., vol.24, no.1, pp.59-64, 2008.

[16] Mohamed Omer Albasha, P.Gupta, and P.W. Ramteke, "Management of Kitchen Waste by Vermicomposting Using Earthworm, Eudrilus Eugeniae",*International Conference on Advances in Agricultural, Biological & Environmental Sciences (AABES-2015)*, July 22-23, London(UK), pp.81-84, 2015.

[17] Shlrene Quaik, Mahamad Hakimi Ibrahim, "A Review on Potential of Vermicomposting Derived Liquids in Agricultural Use", *International Journal of Scientific and Research Publications*, vol.3, no.3, pp.1-6, 2013.

[18] Md. Abul Kashem, Ashoka Sarker, Imam Hossain, Md. Shoffikul Islam, "Comparison of the Effect of Vermicompost and Inorganic Fertilizers on Vegetative Growth and Fruit Production of Tomato(Solanum lycopersicum L.)", *Open Journal of Soil Science*, vol.5, pp. 53-58, 2015.

[19] Lushian T Mupondi, Pearson NS Mnkeni and Pardon Muchaonyerwa, "Effects of a precomposting step on the vermicomposting of dairy manure–waste paper mixtures", *Waste Management & Research*, vol.29, no.2, pp.219-228, 2011.

[20] Pius M. Ndegwa, S.A. Thompson, "Effects of C-to-N ratio on vermicomposting of biosolids", *Bioresource Technology*, vol.75, pp.7-12, 2000.