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Evolution of Composting as a Strategy for Managing Organic Municipal Solid Wastes in Central India

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Abstract: Studies were conducted at Regional office, Madhya Pradesh pollution Control Board and Rani Durgavati University to evaluate the quality of municipal and agricultural waste under aerobic and anaerobic composting. Composting methods with enrichment techniques were adopted with two methods (Aerobic and Anaerobic) and seven treatments in each method. The samples of the aerobic were drawn after 0, 10, 20, 30 and 40 days after composting and in anaerobic compost samples were drawn after 50 days of compost. Effect of bio-inorganic carbonulum (Fungal Consortium), chemical amendments (2% P2O5 and 1% N) and method of composting on organic carbon, C/N ratio, pH, EC and total nutrient status during composting was determined in aerobic and anaerobic composts. The organic carbon, C/N ratio decreased significantly during maturation of the compost irrespective of treatments and method of composting. High organic carbon was recorded in 100 % urban solid waste (USW) compost in both the methods. It ranged from 20.15 % to 24.0 % in aerobic matured compost and from 21.5 to 23.25 in anaerobic matured compost. 100 % agricultural waste (AW) compost had lower C:N ratio 18.65 and 17.47 in aerobic and anaerobic composts, respectively than 100 % USW compost (19.20 to 18.02 in aerobic and anaerobic compost, respectively). Where as the nitrogen content was increased from 0.78 % to 1.29 % in 100 % urban waste compost and 0.75 % to 1.23 % in 100 % agricultural compost. R organic carbon k phosphate treated composts in both methods enhanced the total P content with maximum of 0.89 % in both aerobic and anaerobic composts. There was gradual increase of total potassium content from initial status of 0.44 to 0.64%.

Key words: composting, municipal solid wastes, agricultural wastes.

INTRODUCTION

The population of central India has increased fivefold over the last fifty years undergoing a population explosion in its urban areas mainly due to rural migration. Jabalpur is the one of the major city in the central India with population of (Gautam *et al.,* 2009) urban inhabitants. Municipal solid waste comprises all the wastes arising from human and animal activities. According to WHO (World health organization), solid waste can be defined as useless, unwanted or discarded materials arising from domestic, trade, commercial, industrial and agricultural as well as from public services. Recently municipal solid waste (MSW) management has become a serious environmental problem and one of the major growing concerns for urban areas all over the world. In the typical countries, the major portion of the total solid waste is biodegradable organic matter. The high content of these biodegradable organic matter and other inert material, results in high waste density and high moisture content. Theses physical characteristics significantly influence the feasibility of certain treatment options. Wastes with a high water or inert content will have low calorific value, and thus may not be suitable for incineration usually (Gary *et al.,* 1971; Marugg *et al.,* 1993; Boni and Musmeci 1998). However, composting technology seems to be a good alternative method for managing MSW. Composting is defined as the aerobic biological decomposition and stabilization of organic substrates, under conditions that allow developed met of thermophilic temperature as a result of biologically produced heat. To obtain a final product that is stable, free of pathogens and plant seeds can be beneficially applied to land (Komilis and Ham 2003).

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Composting can also decrease or eliminate the toxicity of MSW (Modini *et al.,* 2006) chemical parameters (pH, electrical conductivity carbon form as, inorganic nitrogen forms and cation exchange capacity) and biological parameters (germination index0, have been used successfully as indicators of compost stability and maturity from different sources(Butler *et al.,* 2001; Copperband *et al.,* 2003). MSW compost stability and maturity are comprehensive properties indicating the degree of organic matter decomposition and potential of phytotoxciy caused by insufficient composting (Eggen and Vethe 2001). The one of the most widely parameters accepted to evaluate compost maturity is the germination index, which is a measure of phytotoxicity, has been considered as reliable indirect quantification of compost maturity (Huang *et al.,* 2006). MSW composting could bring environmental benefits, but it could also create environmental risks, as there is a possibility that pathogens, heavy metals and other phytotxicity contaminations may remain at high level in the composted product, therefore use of plant seeds to indicate compost maturity is seen as a protective approach, since respiration or stability testing does not directly indicate potential plant problems. The purpose of this investigation was to the evolution of organic waste biodegradation with fungal consortium inoculated and it physiochemical analysis.

MATERIALS AND METHODS

The investigation of composting and testing the components in the field were done at Ranital trechniching site, Regional office M.P. pollution control Board and Mycological Research laboratory R.D.V University, Jabalpur (M.P.). to evaluate the quality of compost under aerobic and anaerobic composting. Composting methods with enrichment techniques were adopted with 2 methods (Aerobic and Anaerobic) and 7 treatments in each method. The chopped urban wastes and agricultural wastes (combination of cereals, legumes and oil seeds) were used for rapid composting technique by inorganic carbonulating with Fungal Consortium (1 kg t-1 of waste) and R organic carbon k phosphate (2%P_2O_5) and Urea (1% N) as mineral additives on material dry weight basis. Pre-sampling of urban wastes and agricultural wastes was done for analysis of chemical properties. After 40 and 50 days of decomposition of aerobic and anaerobic composts (for every monthly turnings aerobic compost samples were collected intermittently) samples were collected, dried and ground to pass through 1 mm sieve and used for chemical analysis. pH and electrical conductivity was measured 1:5 sample-distilled water suspension, total organic carbon, total nitrogen, total phosphorus, total potassium using standard prorganic carbonedures (Jackson 1973) and total micronutrients were analyzed by standard method given by (Wong *et al.,*2002) using inductively coupled plasma emission spectroscopy (ICAP).
The treatments involved during composting are:

T1: 100 % Agricultural Waste + Microbe + Urea + Rorganic carbonk Phosphate + Cow dung
T2: 100% Urban Solid Waste + Microbe + Urea + Rorganic carbonk Phosphate + Cow dung
T3: 50 % Urban Solid Waste + 50 % Agricultural waste + Microbe + Urea + Rorganic carbonk Phosphate + Cow dung
T4: 25 % Urban Solid Waste + 75 % Agricultural Wastes + Microbe + Urea +Rorganic carbonk Phosphate + Cow dung
T5: 75 % Urban Solid Waste + 25 % Agricultural waste + Microbe + Urea + Rorganic carbonk Phosphate + Cow dung
T6: 100 % Agricultural Waste + Microbe + Cow dung.
T7: 100 % Urban Solid Waste + Microbe + Cow dung.

RESULTS AND DISCUSSION

Physico-Chemical Properties of Raw Materials used for Composting:

The chemical characteristics of urban solid wastes and agricultural wastes used for the preparation of compost were determined to know the initial nutrient status of raw materials table 1 (Jackson 1973). The two organic solid wastes were slightly alkaline to alkaline in reaction. The urban solid waste had the highest pH of 7.73 and agricultural wastes had 7.56 pH. The electrical conductivity of 1:50 waste water extract was found to be highest in urban solid waste (1.038 μs/cm) than agricultural waste (1.127 μs/cm). The organic carbon in USW was 41% whereas it was 49 % in agricultural waste. The C:N ratio of USW was maximum 70.68 followed by agricultural waste 50.51. The total N content of USW was 0.58 % whereas it was 0.97 % in AW. The total P was more in Agricultural Waste 0.0028 % than Urban Solid Waste 0.0020 %. The total K content of USW was 0.35 % whereas AW contained 0.68 % of total K. Effect of bio-inorganic carbonulum (Fungal Consortium), chemical amendments (2% P_2O_5 and 1% N) and method of composting on organic carbon, C/N ratio, pH, EC and total nutrient status during composting was determined in aerobic and anaerobic composts.. The organic carbon, C/N ratio decreased significantly during maturation of the compost irrespective of treatments and method of composting (Saviozzi *et al.,* 1988).

Table 1: Initial Characteristics of Urban Solid Wastes and Agricultural Wastes

Character of Chemical properties	Urban Solid Waste	Agricultural Waste
pH	7.73	7.56
EC (µs/cm)	1.038	1.127
Organic Carbon (%)	41	49
C:N ratio	70.68	50.51
Ash %	12.96	14.21
Total N	0.58	0.97
Total P	0.0020	0.0028
Total K	0.35	0.68

C:N ratio is one of the most important parameters that determines the extent of composting and degree of compost maturity. Irrespective of the materials used for composting, all the treatments attained drastic decrease of C:N ratio in final product compared to initial raw materials. C:N ratio of the composted materials narrowed down with the advancement of the period of decomposition. It was reported that the C:N ratio narrow down as nitrogen remain in the system, while some of the C is released as CO2 (Sadasivam and Manickam 1993). Further N fixing microbes indirectly help in decreasing C:N ratio by making more N available from added Organic Matter (Rasal *et al.,* 1988., Shinde *et al.,* 1992). In matured composts the reduction in C:N ratio was significant in all the treatments compared to initial sample. Comparatively 100 % AW compost had lower C:N ratio(18.65 and 17.47 in aerobic and anaerobic composts, respectively) than 100 % USW compost (19.20 to 18.02 in aerobic and anaerobic compost, respectively). High organic carbon was recorded in 100 % USW compost in both the methods. It ranged from 20.15 % to 24.0 % in aerobic matured compost and from 21.5 to 23.25 in anaerobic matured compost. Between the different types of composts (urban and agricultural wastes) USW compost showed significantly higher organic carbon (24 and 23.25 % in aerobic and anaerobic composts,) over agricultural waste composts (20.15 and 21.50 % in aerobic and anaerobic composts). The initial pH values of agricultural wastes and urban wastes were ranged from 7.8 to 8.9, respectively, and they showed decrease with the advancement in period of composting from 30 days to 120 days in all the treatments of aerobic compost. Aerobic compost had pH value ranged from 7.4 (T1) to 8.1 (T2). In case of anaerobic method, matured compost (150 days) had the pH value of 7.5 (T1) to 8.2 (T2). Slightly more pH was observed in 100 % USW compost than 100 % agricultural waste compost The Electrical Conductivity (EC) in matured aerobic compost ranged from 0.32 to0.45 µs/cm, whereas in anaerobic compost it was varied from 0.36 to 0.46 dSm-1 significantly high EC was recorded in treatments with chemical additives than non amended treatments. EC of the decomposing material was maximum after 10 days and then decreased up to 40 days in aerobic compost. Due to high initial microbial activity and mineralization, soluble salt content will be high and hence high EC in initial stages. In later stages, as humification prorganic carboneeds the humic fractions might have complexed with the soluble salts and then decreasing the amount of mobile free ions (Saviozzi *et al.,* 1988).

Nutrient Status:

A significant difference in total nitrogen content was observed in composts with chemical additives (1.09 to 1.29 %) when compare to composts with out chemical additives (0.85 to 0.89 %). The total nitrogen content was significantly more in anaerobic compost table 2, than aerobic compost this may be due to minimum losses accounted in anaerobic compost. Maximum total nitrogen content of 1.82 % was found in 100 % USW compost treated with chemical additives and bio-inorganic carbonulum while a minimum of 0.85 % was recorded in 100 % agricultural waste compost without addition of chemical amendments. The apparent increase in total nutrient content in compost is not only due to enrichment but also due to the reduction in weight because of decomposition (Jeevan rao *et al.,* 2007). Results showed that Rorganic carbonk Phosphate charged compost in both the methods enhanced the content of total P in the final product when compared to untreated compost table. 3, this may be attributed due to greater mobilization of P from Rorganic carbonk Phosphate.

A significant difference in total P content was observed in composts enriched with Rorganic carbonk Phosphate (0.028 to 0.047% and 0.84 to 0.89 % in aerobic and anaerobic methods, respectively) and composts without Rorganic carbonk Phosphate (0.51 to 0.57 % and 0.52 to 0.58 % in aerobic and anaerobic methods, respectively) (Saviozzi *et al.,* 1988). The total potassium content was ranged from 0.54 to 0.64 % in aerobic compost and it was varied from 0.56 to 0.64 % in anaerobic compost. Maximum total potassium content of

0.64 % was found in 100 % AW anaerobic compost while a minimum of 0.54 % was recorded in T_1 (aerobic compost). There was a gradual increase of Total K from initial waste to final matured compost table 4.

Table 2: Changes in Total Nitrogen (%) during Aerobic and Anaerobic Composting

Treatment	*Aerobic compost*					Anaerobic compost	
	0 days	10 days	20 days	30 days	40 days	0 days	150 days
T_1	0.47	0.66	1.12	1.32	1.47	0.42	1.24
T_2	0.58	0.76	1.73	1.40	1.22	0.31	0.90
T_3	0.42	0.65	0.98	1.25	1.22	0.52	0.86
T_4	0.45	0.72	1.02	1.36	1.62	0.56	0.98
T_5	0.62	0.85	1.64	1.92	1.82	0.68	1.12
T_6	0.78	0.82	1.67	1.72	1.42	0.94	1.52
T_7	0.65	0.74	1.32	1.52	1.41	0.78	1.14

Table 3: Changes in Total Phosphorus (%) during Aerobic and Anaerobic Composting.

Treatment	*Aerobic compost*					Anaerobic compost	
	0 days	10 days	20 days	30 days	40 days	0 days	150 days
T_1	0.0028	0.0045	0.0072	0.012	0.028	0.47	0.84
T_2	0.0020	0.0052	0.0068	0.032	0.046	0.55	0.89
T_3	0.0034	0.0048	0.0072	0.021	0.032	0.52	0.86
T_4	0.0038	0.0056	0.0082	0.024	0.036	0.54	0.87
T_5	0.0045	0.0068	0.0086	0.028	0.042	0.53	0.86
T_6	0.0037	0.0062	0.0078	0.027	0.047	0.44	0.52
T_7	0.0042	0.0064	0.0089	0.032	0.042	0.52	0.58

Table 4: Changes in Total Potassium (%) during Aerobic and Anaerobic Composting.

Treatment	*Aerobic compost*					Anaerobic compost	
	0 days	10 days	20 days	30 days	40 days	0 days	50 days
T_1	0.32	0.35	0.42	0.48	0.54	0.42	0.59
T_2	0.38	0.44	0.52	0.56	0.62	0.47	0.64
T_3	0.42	0.46	0.48	0.55	0.59	0.45	0.58
T_4	0.45	0.48	0.52	0.58	0.64	0.45	0.61
T_5	0.30	0.38	0.47	0.52	0.56	0.45	0.60
T_6	0.44	0.48	0.50	0.54	0.58	0.42	0.58
T_7	0.46	0.47	0.49	0.53	0.57	0.47	0.56

Conclusions:

Method of composting also influenced the nutrient status of compost, bio-inorganic carbonulum improved the decomposition for production of mature and quality compost. The organic carbon, C/N ratio decreased significantly during maturation of the compost irrespective of treatments and method of composting. Rorganic carbonk Phosphate charged compost in both the methods enhanced the content of total P in the final product when compared to untreated compost. Aerobic compost is preferred in a lesser time and to get rid off the bad odour of degrading organic wastes. With regard to the nutrient conservation, nutrient losses are minimum in anaerobic compost.

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