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Municipal solid waste compost characteristics

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AT PRESENT THE municipal solid waste composting is being encouraged in many countries of the world and researchers have experienced the benefits of using MSW compost in the field (Abigail 1998, Francis 1997, John Haynes 1997, Paul Relis & Howard Levenson 1997). For the future sustainable development, it is essential to establish sound economical and technical methods of solid waste management.

Unfortunately the Karachi Municipal Corporation (KMC) are not contributing in the proper management of organic wastes, except few NGO's, which are involved in promoting composting process of domestic solid waste. All this is done on unscientific lines and without the support and cooperation of civic bodies.

Keeping in view the quantum of MSW generation in the city of Karachi (6000-8000 tons per day) and huge cost for its disposal, the present research study was conducted to select an appropriate system, to treat the organic wastes. A pilot study was designed to assess the feasibility of composting of source separated organic matter generated in low, middle and high income areas of the city. The other objective was to evaluate the quality of finished compost as per requirement for soil conditioning and fertilizer. This investigation is expected to minimize raw material wastage and also help in the establishment of guidelines and regulations for the production and use of MSW compost.

Methodology

The research study was conducted in the month of December 1999. Samples of domestic solid waste were collected from 6 different localities of Karachi city, representing high, middle and low socio-economic areas. The organic material mainly vegetable, fruit and kitchen waste etc. were separated manually, weighed and subjected to windrow type composting process, to convert it to organic fertilizer (Haug 1980)

A pile of mixed solid waste (organic waste) of 3 feet high was placed on concrete surface/paved ground and was watered regularly to maintain optimum moisture content (about 45-55 per cent) and turned manually every 3-5 days to homogenize the material for the first six weeks of composting cycle. Starting the seventh weeks, the moisture was allowed to drops. After the optimum biosolids decomposition, which was completed in about 8-9 weeks, the compost was allowed to cure for additional 3 weeks without turning. The finished compost was then screened out and weighed. Representative samples were ground to homogenous powder in a miller apparatus and analyzed in the laboratory to evaluate the compost quality.

The physical and chemical characteristics such as pH, soluble salts, organic matter, essential plant nutrients (nitrogen,phosphorus, potassium) of various compost samples, sample of cowdung (organic fertilizer) and commercial fertilizer were analyzed. To determine the precision and accuracy of the results, each sample was analyzed 5-10 times for each parameter. The details of the analysis are presented elsewhere (ASTM 1990,APHA, AWWA, WPCF 1990 & Dr. Brawn 1990). Carbon percentage was calculated according to the Newzealand formulae (Inter Department Committee 1951), in which percent organic matter present in the sample is divided by 1.724.

Results and discussion

The presence of high percentage of biodegradable organic matter ranging from (71-74 per cent) and the average chemical composition of putrescible matter in domestic refuse are shown in Table 1 & 2. Comparison of the average values of C/N ratio (40:1), pH (6.4), organic matter (57 per cent), and moisture content (36 per cent) of the MSW against those of standards value, indicate that the organic fraction of refuse is suitable for composting process. However the C/N ratio of the waste can be adjusted to an optimum level by supplementing with nitrogen or carbon in the form of organic waste such as cow manure, poultry manure, yard waste etc. It was reported (Flintoff 1976), that te refuse generating in India, Maxico and Great Britain is compostable in nature, as also established by PCSIR study (Khatib et al 1990), and confirmed during the present research study.

The composting procedure adapted in the pilot study was of aerobic windrow type. Advantage of windrow composting process over other composting process is that, its capital, operational and maintenance cost are relatively low (Haug 1980& Technobanoglous 1993). Moreover this method is best suitable for the tropical climate like of Karachi, where the average temperature ranges between 20 and 32 ^{o}C and humidity between 49 and 75 percent. Summer season last long for eight-month extending from end of March to October and the winter season is not very cold.

During composting process it was observed that the mixture heated up rapidly, reaching a temperature of 48 ^{o}C after one day of composting. After maintaining the temperature (48-50 ^{o}C) for initial 3 days of the process, the frequency of turning (mixing) of the waste was increased to maintain temperature between 35-40 ^{o}C, (an optimum level for microbial degradation). It was noted that, in winter season, the composting process was completed in

about 8-10 weeks, whereas in summer season it took only about 4-6 weeks. The weight reduction in winter season was found to be more than 60 per cent, where as in summer it was above 70 per cent. This observation/result is consistent with other research studies (Andrea et al 1998). The maturity of the compost was assessed by placing compost sample in a sealed bag for a week. After a week, the seal was broken and the odor was smelled, which was found to be very earthy smell, indicating that the quality of the compost was stable and mature. The compost samples were then screened out and analyzed in order to evaluate its quality.

Standard procedures were followed for the analysis of compost samples. The results are presented in Table 3 and 4, and also compared against those of International Standards set for good quality compost. The pH value (6.8-8.1) and soluble salts (3.90–5.10 m.mhos / cm) in the compost samples were found to be within the acceptable limits. A high organic matter content ranging (45–60 per cent) was noted. The C/N ratio (26-27.0), lies within the acceptable limits but inclined towards the higher values meaning the compost may need supplements to increase nitrogen value.

Table 1. Compositions of municipa solid wastes in high middle and low socioeconomic localities

Components	High	Middle	Low
		(% by weight)	
Food wastes	74.10	73.45	71.15
Paper & Cardboard	9.30	6.92	4.33
Plastic & polythene	6.00	9.50	13.72
Textile	1.50	2.73	5.40
Rubber & Leather	1.10	1.30	-
Metals & Tin	3.60	1.90	-
Glass	4.40	3.10	1.60
Miscellaneous	-	1.10	3.80

Table 2. Average chemical composition of municipal solid waste

Parameters	Average Values	Standards
PH	6.4	5.5-8.0
Moisture (% dry basis)	36	< 50
Organic matter (% wet basis)	57	> 20
Nitrogen (% dry basis)	0.81	> 0.6
Carbon (% dry basis)	33	No specs
C/N ratio (total dry weight)	40:1	25-50:1

The research studies proved that usually the nitrogen concentration in the compost sample is less available than the nitrogen in the feedstock from which the compost is made due to volatilization of ammonia (Paul & Jessie 199).Therefore it is important to balanced the feedstock to ensure the loss of nitrogen that is reduced. With regard to agronomic parameters, the quantities of essential plant nutrients, especially nitrogen content (0.91–1.35 per cent), phosphorus (0.42-0.85 per cent) and potassium (1.00-1.80 per cent), were found to be in acceptable concentration for soil conditioning. However the excellent quality of compost contains high percentage of nitrogen content, whereas no specific international standard has yet been set for phosphorus and potassium concentration content.

Table 4, also shows the quality comparison of the compost produced from MSW against those of organic fertilizer (cowdung) and chemical fertilizer sample. The compost prepared during the present study was found to be as good as cowdung and chemical fertilizer. However, the compost derived from MSW has following additional advantages over the chemical fertilizer.

- It can be used as soil conditioner to improve aeration, aggregation and water holding capacity and cation exchange capacity of the soil.

Table 3. Comparative average values of pH, soluble salts, organic matter content of compost, cowdung and chemical fertilizer samples.

Sample Type	pH	Soluble salts (m.mhos/cm)	Organic matter (%dry basis)
MSW Compost (High income)	7.50 (6.8-7.8)	4.19 (3.90-4.50)	58 (56-60)
MSW Compost (Middle income)	7.42 (7.1-8.0)	4.72 (4.35-4.82)	56 (54-58)
MSW Compost (Low income)	7.78 (7.0-8.1)	4.83 (4.72-5.10)	48 (45-50)
Cowdung (organic fertilizer)	7.91 (7.6-8.2)	4.81 (4.75-4.88)	50 (48-52)
Chemical fertilizer	6.95 (6.8-7.1)	5.67 (5.40-5.80)	38 (37-39)
Proposed Italian Standard	5.5-8.0	<5	>20

* Parenthesis shows the range

- The compost helps to prevent erosion, supplies slow release of nutrients and can control numerous soil born diseases (Abigail 1998,JohnHaynes1997).

Conclusion

Since the Karachi soil are sandy, highly erodible, even light rain causes severe rilling and gullying, contains little organic matter, nutrients and low water holding capacity. These deficiencies could be improved by adding MSW compost. Moreover the application in the Karachi soil would be an investment in the long-term for the health of soils and plants. It is concluded that composting technique for the recovery of valuable and economical organic fertilizer- the compost, can be adapted country wide to recycle the organic residuals as waste management option

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Table 4. Comparative average nutritional values and C/N ratio of composts, cowdung and chemical fertilizer samples

Sample Type	Org.Carbon (%)	Nitrogen (%) dry basis	Phosphorus (%) dry basis	Potassium (%) dry basis	C/N Ratio
MSW Compost (High income)	31.90	1.18 (0.94-1.35)	0.57 (0.42-0.70)	1.61 (1.30-1.80)	27.03
MSW Compost (Middle income)	29.58	1.11 (0.95-1.18)	0.58 (0.45-0.72)	1.58 (1.20-1.80)	26.64
MSW Compost (Low income)	27.80	1.09 (0.91-1.20)	0.64 (0.55-0.85)	1.32 (1.00-1.50)	25 50
cowdung (organic fertilizer)	29.00	1.19 (0.95-1.50)	0.55 (0.43-0.65)	3.81 (3.10-4.40)	24.37
Chemical fertilizer	22.00	0.86 (0.73-0.98)	0.75 (0.55-1.00)	0.18 (0.16-0.20)	25 58
MSW Compost Quality Standard	>25	>1	-	-	<25

* Parenthesis shows the range.