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LOW TECHNOLOGY CO-COMPOSTING OF MUNICIPAL SLUDGE AND CROP RESIDUES FOR PRODUCING CLASS A BIOSOLID

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ABSTRACT

With the growing prominence of environmental concern and the attendant crisis in waste management, a new economic approach to composting is needed. Six static piles, without agitation during the composting process, were built; three 1 m^3 piles and three 4.5 m^3 piles. Wastewater treatment sludge (WWTS) was mixed with wheat straw as bulking agent. Temperature, moisture, organic matter, C/N ratio, pH, and EC were monitored during the composting process. Results indicated that the static piles were able to maintain adequate oxygen passively through natural diffusion and convection. The temperature was maintained between 40 and 65°C, and by exceeding 55°C would kill fecal coliform (FC), parasites, and plant pathogens. Greater heat loss was observed in the 1 m^3 piles than in the 4.5 m^3 piles. The composting process involved an initial mesophilic phase during which compost temperature rose rapidly, thermophilic phase in which temperatures exceeded 55°C for more than 3 days, and a stabilization phase in which compost temperature declined to ambient temperature. Compost stability/maturity were tested by measuring biochemical oxygen demand (BOD), chemical oxygen demand (COD), CO_2 evolution, absorbance ratio at 420 and 665 nm (E4/E6), and seed germination index (GI). The GI reached 100 % after 143 days in the 1 m^3 piles and after 86 days in the 4.5 m^3 piles, and was significantly correlated with the other tests. The finished compost met the Class A biosolids criteria with respect to FC density and heavy metals concentrations, and proved superior to peat as a substrate for cucumber and vinca.

Key words: Co-composting / biosolids / plant residues / compost quality / static piles

INTRODUCTION

In recent years, concerns over the disposal of WWTS and of crop residues (CR) have been accelerated and composting appears to be promising avenue for their management. Sludge is the semi-solid end product of wastewater purification; now termed biosolids (Turovskiy, 2000). The sludge is rich in nutrients (Sommers, 1977), and during the wastewater treatment process pathogens and heavy metals become concentrated in it. To ensure destruction of pathogens and stabilize the biodegradable organic matter composting may be employed (Rechcigl, 1995), under condition that would allow development of thermo phase (Haug, 1993). The crop residues (CR) serves as bulking agent providing the compost necessary structure and porosity to facilitate aeration, decreasing the moisture and heavy metals contents of the sludge, and enhancing the aerobic and thermophilic activities(Goldstein, 1997). The main products of aerobic composting are CO_2, water, mineral ions, and stabilized organic matter; often called humus (Inbar et al., 1990). Methane, plant toxic organic acids, and noxious odors released in the environment are major products of the anaerobic processes (Cameron and Koch, 1980).

A variety of composting technologies have been adapted, which can be roughly divided into four groups: passive aeration static piles, aerated static piles, turned windrows, and in-vessel. Static piles are not agitated during the composting process. Passive composting depends on oxygen diffusion, thermal convection, and wind blowing (Rynk, 2000), and is a low technology method. Oxygen replenishment in the aerated static pile is provided by forced aeration through pipes located in the base of the pile, which encourages rapid rates of decomposition (Sylvia et al., 1998). Turned windrow piles are arranged in triangular-shaped rows that are mechanically agitated or turned periodically to replenish oxygen. They are space-intensive as well as labor intensive, and result in odor production and ammonia loss (Rynk, 1992). In-vessel composting takes place in either partially or completely enclosed containers employing various forced aeration and mechanical turning technologies, which are costly in terms of capital and maintenance costs (Tchobanoglous and Burton, 1991).

Key parameters in the composting process are the available carbon to nitrogen (C/N) ratio, moisture, oxygen, and temperature (Richard, 2001). Carbon serves primarily as an energy source for the microorganisms, while nitrogen is critical for microbial population growth. Compost stability/maturity is a critical issue as immature compost can be detrimental to plant growth and the soil environment. Compost stability is defined as where microbial activity diminishes along with available organic carbon and other energy sources, while maturity refers to the phyto-toxicity associated with the compost (US Composting Council, 1997).

Main objective of this study was to develop a low and inexpensive technology for co-composting WWTS and CR to produce a biosolid that meets EPA (US Environmental protection agency) criteria for Class A. The specific objectives were to: (i) investigate the composting process in static piles under passive aeration, (ii) monitor compost stability/maturity through measuring BOD, COD,

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optical density, CO_2 evolution, and GI, (iii) evaluate compost quality with respect to FC density, heavy metals and chemical composition, and (iv) assess the finished compost as substrate by conducting cucumber and vinca growth experiments.

MATERIALS AND METHODS

Composting System

The biosolids were obtained from a secondary wastewater treatment (WWT) after the secondary clarifiers. They had high moisture content of about 98% and low C/N ratio of about 6.94. Air dried wheat and rice straw were chopped into about 2-4 cm segments. The straw moisture content was in the 6-10% range and C/N ratio ranged from 76 to 89. Biosolids were mixed with wheat or rice straw as bulking agents to give a C/N ratio of 34 to 39 as recommended by Golueke (1977) and moisture content in the 50-55% range, which is considered optimum for composting (Haug, 1993).

Static experimental piles, without agitation during the composting process were built in an Egyptian village to test the aeration system and the pile size effects. Each pile was placed on a 10-cm bed of cotton stalks, and covered with plastic sheets for insulation. Preliminary studies indicated that the static piles were able to maintain adequate oxygen passively through natural diffusion and convection; without the need for positive aeration provided through the base of the pile. Also, decomposition rate was lower with rice straw than with wheat straw. Therefore, only reported here are data for wheat straw passively aerated piles, depending on natural ventilation for replenishing O_2. Six static passively aerated piles were built with a perforated plastic pipe (10-cm diameter) placed in the middle of the pile to enhance ventilation. Three were 1 m^3 piles (1x1x1 m) and the other three were 4.5 m^3 piles (1.5 x 1.5 x 2 m).

Monitoring Composting Process

The following compost parameters were monitored: temperature, moisture content, pH, electrical conductivity (EC), organic matter content, and C/N ratio. The temperature was measured every 1 to 3 days during the high rate thermophilic phase and less frequent during the stabilization phase, in addition to the ambient temperature. Triplicate compost samples were taken weekly for measuring moisture content by drying overnight at 105°C, ash content by heating in a muffle at 480°C for 8 hours, and organic matter (OM) content by loss of ignition, and 50 % of OM was considered organic C (Laos et al. 2002). EC and pH were measured in the saturated compost extract. Total nitrogen was determined by Kjeldahl method (Stevenson, 1982) and total heavy metals concentrations were measured by atomic absorption after wet digestion. Total phosphorus was estimated colorimetrically after wet digesting the air dried compost samples in concentrated $HNO_3 + HClO_4$ (2:1) (Jones and Case, 1990). Cation exchange capacity was determined in $BaCl_2$-by Gilman method (Rhoades, 1982).

Stability/Maturity Indices

Carbon dioxide evolution was estimated by sucking air from the pile center into 1.0 M NaOH solution, and titrating excess NaOH with 0.5 M HCl after precipitation as barium carbonate (Anderson, 1982). Germination test was conducted periodically on compost samples using Cress (*Lepidium sativum* L.); by placing compost layers of 5 mm thickness in Petri dishes, covering with filter paper and soaking to water saturation (Zucconi el al. 1985). Chemical oxygen demand (COD), biochemical oxygen demand (BOD) and optical density were determined in water extracts obtained by suspending compost samples in hot water at 60°C in 1:10 wet weight ratios and shaking for 30 min (Mathur et al., 1993). The suspensions were centrifuged at 10000 g and the supernatant passed through No. 42 Whatman filter paper. The COD was estimated by the dichromate reflux method (5220C) (APHA, 1998). The 5-day BOD test (5210 B) was employed to estimate the biodegradable organic matter in the extract as described in APHA (1998). Optical density of filtered hot water extracts was measured as absorbance at 465 and 665 nm on the spectrophotometer. The compost extract was tested for fecal coliform as pathogens indicator through determining the most probable number (MPN) by the multiple-tube procedure (922 1 E) of the APHA (1998).

Compost As Substrate

Physical properties of the compost, i.e. bulk density, particle density, total porosity, container capacity, and air space were determined as described by Inbar et al. (1986). Two greenhouse trials were conducted to evaluate the finished compost as a substitute for peat, by growing cucumber in trays and vinca in pots. The treatments compared compost, peatmoss, sand, compost + peatmoss , and compost + sand as medium for plant growth. Cucumber (*Cucumis sativus* L.) seeds were sown at 1 seed/1 cell in 100 cells polystyrene trays (cell volume 80 cm^3); filled with each medium (10 replicates) and without nutrients addition. Vinca (*Catharonthus roseus* L.) seeds were sown at 20 seeds per pot (785 cm^3). Cucumber was harvested after 40 days, while vinca was harvested after 60 days. Plants were separated into shoots and roots, washed and weighed after drying at 70°C.

RESULTS AND DISCUSSION

Composting Process

Heat production in the pile depends on its size, moisture content, aeration and C/N ratio, in addition to the ambient (indoor or outdoor) temperature. As expected, the temperature was always higher at the pile centre than at the top and was the least at the edges. The temperature data reported here are those taken by a mercury thermometer placed close to the pile centre. Temperature measured at the pile center peaked within 5 days to 59°C in the 1 m^3 pile compared to 65°C in the 4.5 m^3 pile (Fig. 1A); associated with peak moisture content (not shown). This was followed by a gradual drop, during which the 4.5 m^3 pile consistently maintained higher temperatures than the 1 m^3 pile; reflecting greater heat losses in the smaller pile through aeration and surface cooling. The smaller the pile the greater the surface area to volume ratio, and therefore the larger the degree of heat loss due to conduction and radiation (Richard, 2001). The temperature was maintained between 40 and 65°C, which is considered optimum for composting, and by exceeding 55°C would kill fecal coliforms, parasites and plant pathogens (Keener et al., 2000).

As shown in Fig. 1A the composting phase involved three sub-phases: (i) an initial mesophilic phase lasting 2 days during which compost temperature rose rapidly; (ii) a high rate thermophilic phase in which temperatures rose above 40°C lasting about 20 days in the 1 m^3 pile and 50 days in the 4.5 m^3 piles, and (iii) a stabilization phase during which the compost temperature declined to ambient temperature lasting 32 days in the 1 m^3 pile and 65 days in the 4.5 m^3 pile. Metabolic heat was trapped to a greater extent in the 4.5 m^3 than in the 1 m^3 piles, resulting in higher compost temperature for longer period in the former pile which accelerated the composting process. Both pH and EC peaked to higher values within relatively shorter periods in the 4.5 m^3 than in the 1 m^3 pile (Fig. 1 B and C). During 200 days of composting the 1 m^3 pile organic matter decreased from initial 89.9% to final 61.3%, C/N ratio decreased from 34.6 to 18.4, and N increased from 1.3% to 1.7%. For the 4.5 m^3 pile during 86 days composting, organic matter decreased from 91.9% to 59.2%, C/N ratio decreased from 39.6 to 16.0 and N increased from 1.2 % to 1.9 %. In other words, the composting process proved more efficient in the 4.5 m^3 pile than in the 1 m^3 pile.

Compost Stability/Maturity Evaluation

Compost Stability refers to the degree to which the organic fraction in the compost has been decomposed, and is an indication of the potential for microbial growth on the substrate. It was tested by water extract analysis for BOD, COD and absorbance at 465 and 665 nm as well as by CO_2 evolution. On the other hand, compost maturity refers to the phytotoxicity associated with the compost and was tested by the seed germination index.

All piles exhibited a sharp increase in BOD within the first 10 days followed by a rather rapid decline (Fig. 2A); for the 10:1 water extract of 1 g dry compost (dw) passed through whtman 42. The first 10-day average increase was from 39 mg to 55 mg, and from 36 mg to 63 mg for the 1m^3 and 4.5 m^3 piles, respectively. Then BOD dropped to around 11 mg after 143 days in the 1 m^3 piles and after 86 days in the 4.5 m^3 piles. It is presumed that changes in BOD reflect hydrolysis and oxidation of certain substrates. Expressing BOD as mg of O_2 g^{-1} of total dissolved organic carbon in the water extracts revealed that the biodegradability of the extracted organic matter declined with time (Mathur et al., 1993). In other words, BOD of the extracts increased as decomposition began and then declined as the compost matured. Mathur et al. (1993) considered that the composts were mature when BOD of the compost water extract passed through 0.45 µm millipore filter paper was < 5 mg. The COD behaviour was similar to that of BOD (Fig. 2A), and their values were highly correlated ($r^2 = 0.95^{***}$, n = 32).

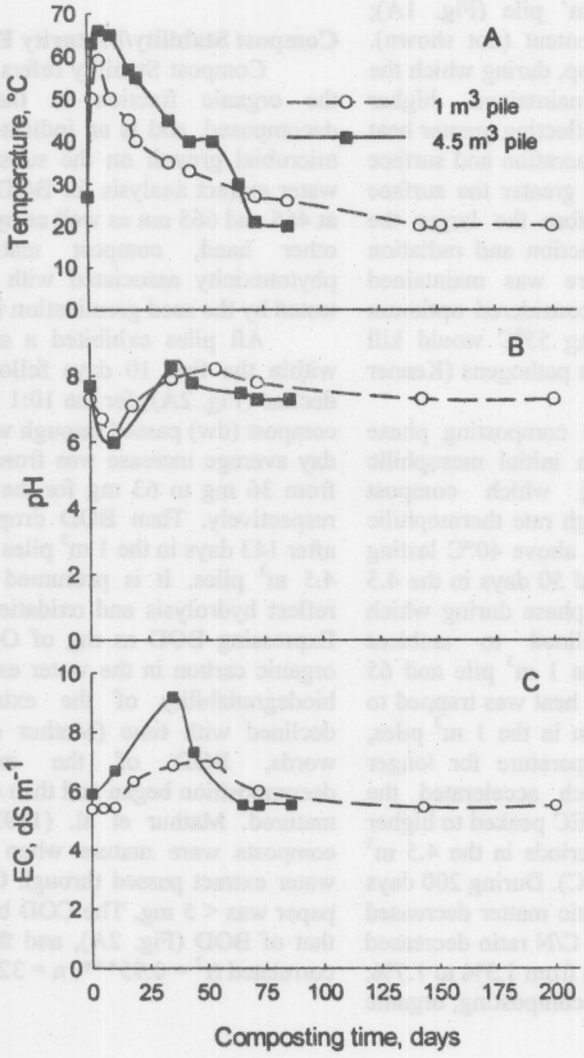

Fig. 1. Changes in temperature (A), pH (B), and EC (C) during composting period of the 1 m^3 and 4.5 m^3 piles.

The COD values were higher than those of BOD as they include oxidation of organics that are not readily biodegradable. A BOD to COD ratio of 0.56 was noted in the compost water extract, which is close to that of 0.6 in typical municipal wastewater (Kiely, 1998). The average COD dropped to 15 mg after 143 days in the 1 m^3 piles and after 86 days in the 4.5 m^3 piles. The COD test offers the advantage that it takes only 2 hours to measure whereas the BOD requires 5 days to measure. It may be noted that Lasaridi and Stentiford (1998) considered COD not suitable for assessing the degree of compost stability.

Absorption spectra at 465 nm and at 665 nm for the different piles were generally featureless, devoid of well defined maximum. However, there was a tendency for E4 and E6 to decrease with composting time. Mathur et al. (1993) considered E6 absorption as a reliable test for regulatory determination of compost maturity. But Lasaridi and Steniford (1998) findings with sewage sludge and other composts did not support that absorbance at 665 nm is a good stability indicator. Average E4/E6 ratios of water extracts for the 1 m^3 and 4.5 m^3 piles are plotted in Fig. 2B indicating general increase with composting time. The E4/E6 ratio for the 1 m^3 piles averaged 4.3 at initiation of the composting process and increased to 7.3 by the end of 200 days. The E4/E6 ratios for the 4.5 m^3 piles were 4.5 at initiation and increased to 7.4 within 92 days. These findings are quite similar to those of Mathur et al. (1993) as the E4/E6 ratios were around 4 at initiation and increased to around 7 for four types of composted mixtures. The E4/E6 ratio promises to be a facile test for compost stability as it involves hot water extraction and colorimetry.

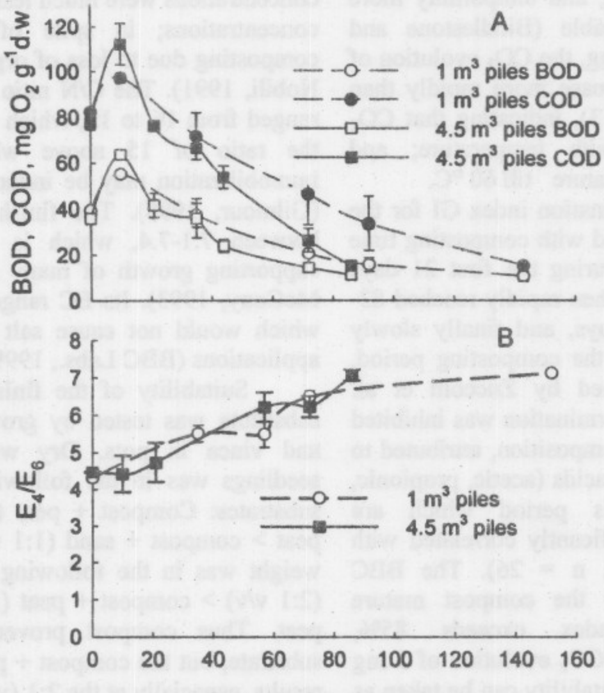

Fig. 2. Changes in water extract BOD and COD (A) and E4/E6 absorption ratio (B) during composting period of the 1 m^3 and 4.5 m^3 piles. Error bars show standared error of the mean.

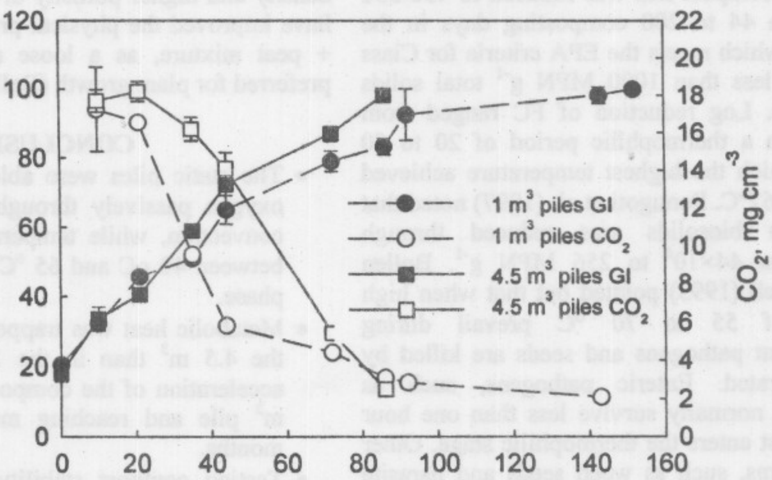

Fig. 3. The average CO$_2$ evolution and seed germination index during composting period of the 1 m^3 and 4.5 m^3 piles.

As illustrated in Fig. 3 all piles reached a maximum average CO_2 evolution of 17.3-18.2 mg cm^{-3} within 10-21 days, then decreased gradually to 4.4-5.5 mg cm^{-3} after 72 days; after which CO_2 levelled off at 2.1-2.5 mg cm^{-3} as the readings stabilized. As composting begins, large organic molecules are broken down to smaller, soluble ions, and temporality more substrate may become available (Biddlestone and Gray, 1987). During composting, the CO_2 evolution of the 1 m^3 piles tended to decrease more rapidly than that of the 4.5 m^3 piles (Fig. 3), indicating that CO_2 evolution was associated with temperature; and increased with compost temperature till 60 °C.

The average seed germination index GI for the 1 m^3 and 4.5 m^3 piles increased with composting time (Fig.3). It slowly increased during the first 21 days from 18.3-20.6% to 40-45%, then rapidly reached 83-87 % after 72 composting days, and finally slowly reached 100% by the end of the composting period. Similar findings were obtained by Zucconi et al. (1981) who found that seed germination was inhibited during the early stages of decomposition, attributed to low molecular weight organic acids (acetic, propionic, butyric) formed during this period which are phytotoxic. The GI was significantly correlated with CO_2 evolution (r^2 = 0.85**, n = 26). The BBC Laboratories (1999) consider the compost mature when the germination index exceeds 85%, corresponding in this study to CO_2 evolution of 5 mg cm^{-3}. In other words, compost stability can be taken as one indicator of maturity.

Finished Compost Quality

Fecal coliform (FC) density in the initial activated sludge-crop residues mixture was around 20 × 10^4 MPN g^{-1} compost and was reduced to 430-230 MPN g^{-1} within 44 to 200 composting days in the different piles; which meets the EPA criteria for Class A biosolids of less than 1000 MPN g^{-1} total solids (USEPA, 1993). Log reduction of FC ranged from 2.68-2.96 within a thermophilic period of 20 to 50 days, during which the highest temperature achieved ranged from 59-67°C. Ponugoti et al. (1997) noted that FC density in biosolids was reduced through composting from 44×10^6 to 256 MPN g^{-1}. Bollen (1993) and Farrell (1993) pointed out that when high temperatures of 55 to 70 °C prevail during composting, plant pathogens and seeds are killed by the heat generated. Enteric pathogens, such as salmonella spp., normally survive less than one hour once the compost enters the thermophilic stage. Other noxious organisms, such as weed seeds and parasite eggs may be more durable, but are often eliminated or greatly reduced during composting.

Compost quality depends on the chemical composition of the various feedstocks used to construct the piles as well as on the success of the composting process. Ranges in the chemical composition of the finished compost from the different piles are reported in Table 1, for comparison with MSW compost (Tao et al., 1995), biosolids + bedding compost (Fauci et al., 1999), and the USEPA (1993) ceiling concentrations for heavy metals. The finished compost had the highest K content and the least heavy metals concentrations (except for Cd). Heavy metals concentrations were much less than the USEPA ceiling concentrations; in spite of their increase during composting due to loss of organic material (Leita and Nobili, 1991). The C/N ratio of the finished compost ranged from 16 to 19, which is somewhat higher than the ratio of 15 above which temporary net N immobilization may be induced after soil application (Gilmour, 1998). The finished compost pH ranged between 7.1-7.4, which is considered suitable for supporting growth of many plant species (Dick and McCony, 1993). Its EC ranged from 5.4 to 6 dS m^{-1} which would not cause salt toxicity in horticultural applications (BBC Labs., 1999).

Suitability of the finished compost as a peat substitute was tested by growing cucumber in trays and vinca in pots. Dry weight of the cucumber seedlings was in the following order for the tested substrates: Compost + peat (1:1 v/v) >> compost > peat > compost + sand (1:1 v/v) >> sand. Vinca dry weight was in the following order: Compost + peat (2:1 v/v) > compost + peat (1:1 v/v) >> compost >> peat. Thus compost proved superior to peat as substrate, but the compost + peat mixtures gave better results, especially at the 2:1 (v/v) ratio. In other words, it seems that compost and peat complemented each other. Compost superiority to peat can be attributed to the higher nutrients contents in compost and its lower C/N ratio especially as both cucumber and vinca were not fertilized. On the other hand, the lower bulk density and higher porosity of the peat (Table 2) may have improved the physical properties of the compost + peat mixture, as a loose and porous medium is preferred for plant growth (Ball, 1985).

CONCLUSIONS

- The static piles were able to maintain adequate oxygen passively through natural diffusion and convection, while temperatures were maintained between 40 oC and 65 °C during the composting phase.
- Metabolic heat was trapped to a greater extent in the 4.5 m^3 than in the 1 m^3 pile, resulting in acceleration of the composting process in the 4.5 m^3 pile and reaching maturity within about 3 months.
- Testing compost stability by different methods indicated that absorbance ratio at 420 nm and 665 nm of the water extract promises to be a facile test.
- Co-composting reduced the fecal coliform density from 20×10^4 MPN g^{-1} in the initial sludge-straw mix to 230-430 MPN g^{-1} in the finished compost;

which meets the EPA criteria for class A biosolids of less than 1000 MPN g^{-1} total solids.

- All heavy metals in the finished compost were well below the EPA limits by several order of magnitudes.
- Compared with other four composts, the finished compost was the heighest in K content, next to chicken manure in N, and the lowest in P; which can be easily corrected.
- Results obtained with cucumber and vinca indicate that compost was superior to peat as a substrate, but the compost plus peat mixture gave relatively better resuls.

Table 1. Analysis of finished compost compared with municipal solid waste (MSW) compost, biosolids + bedding compost, and USEPA heavy metals ceiling concentrations.

Properties	Finished compost	USEPA ceiling	MSW compost	Biosolids bedding
N (%)	1.58-1.85		1.28	1.73
P (%)	0.43-0.48		0.66	0.52
K (%)	1.84-2.6		0.32	1.20
C/N	16-19		24.4	21
pH	7.1-7.4		7.7	7.3
EC (dSm^{-1})	5.36-6.01		4.54	2.8
O.M (%)	59-61		62	36 (C%)
Moisture (%)	33-36		50.5	
Heavy metals (mg kg^{-1})				
Fe	2047-3362		20000	10000
Zn	89-108	2800	655	160
Mn	112-142		501	540
Cu	110-140	1500	281	75
PB	9.0-11.5	300	234	36
Ni	0.85-0.93	420	34	17
Cd	5.5-73	39	3.3	1.8
Co	12-13			8.0

Table 2. Physiochemical characteristics of peat, sand, and compost

Parameter	Peat	Sand	Compost
Bulk density (gcm^{-3})	0.09	1.58	0.22
Particle density (g cm^{-3})	0.61	2.64	1.81
Total porosity (%)	95.20	40.4	87.80
Air space (%)	26.10	7.90	19.05
Container capacity (%)	79.10	32.50	68.55
water holding capacity (g kg^{-1})	3465	12.80	4597
pH	7.00	7.5	7.25
EC (dSm^{-1})	0.51	1.50	5.85
Total N (%)	0.81	0.40	1.78
Total P (%)	0.20	0.05	0.41
Total K (%)	0.22	0.01	2.22
C/N	40	0.25	17.5
CEC (cmol kg^{-1})	130.4	4.30	89.85

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الملخص العربى

انتاج كمبوست مرتفع الجودة بالكمر المذدوج للحمأة الرطبة والمخلفات النباتية وبتقنية بسيطة

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يقتضى الاهتمام المتزايد بالبيئة وما يصاحبه من اهتمام بالادارة البيئية السليمة للمخلفات ايجاد طرق جديدة غير مكلفة وقابلة للتطبيق لتدوير تلك المخلفات والاستفادة منها. ولذا كان الهدف من هذا البحث هو التوصل الى انتاج سماد عضوى (كمبوست) عالى الجودة من المخلفات الصلبة الناتجة من الصرف الصحى (الحماة الرطبة). لذلك اجريت تجربة بعمل ٦ مكمورات ثابتة (بدون اجراء اى تقليب للكومة خلال فترة الكمر)، ثلاثة منها ذات حجم ١م^{٣} والثلاثة االاخرى ذات حجم ٤,٥ م^{٣} للمكمورة. وقد تم خلط الحمأة قبل تجفيفها مع بقايا نبات القمح كمادة مالئة حتى الوصول الى محتوى رطوبى ٥٠ – ٥٥ % ونسبة كربون الى نيتروجين (C/N ratio) ٣٤ – ٣٩ %. وتم تتبع درجة الحرارة، الرطوبة، المادة العضوية، نسبة الكربون الى النيتروجين، درجة الحموضة pH، وكذلك الملوحة EC خلال فترة الكمر.

وقد اوضحت النتائج انه فى هذة الكومات الثابتة يمكن الحفاظ على نسبة الاكسجين اللازمة لانتاج السماد العضوى فى ظروف هوائية من خلال معدلات الانتشار والتسرب الطبيعية للغاز. وكانت درجات الحرارة داخل المكمورات ما بين ٤٠ و٦٥ °م خلال فترة التخمر الاولى وقد ادت زيادة درجة الحرارة عن ٥٥ °م على قتل الميكروبات الممرضة وبذور الحشائش. وقد لوحظ ان الفقد فى درجات الحرارة فى المكمورات ذات الحجم ١م^{٣} اعلى منه فى المكمورات ذات الحجم ٤,٥ م^{٣}. وقد تضمنت عملية الكمر ثلاثة اطوار، الطور الاول وهو طور معتدل الحرارة Mesophilic phase وتزداد فيه درجة الحرارة الى نحو ٤٠ °م. يلى ذلك الطور الحرارى Thermophilic phase وتزداد فيه درجة الحرارة عن ٥٥ °م ، ثم طور الاتزان Stabilization phase وتنخفض فيه درجة الحرارة الى المستوى الطبيعى وتستمر هكذا حتى النضج.

وقد تم اختبار درجة نضج المكمورات بتتبع الأكسجين الحيوى BOD، والأكسجين الكيميائى COD، وثانى اكسيد الكربون الناتج، ونسبة الامتصاصية عند ٤٢٠ و ٦٦٥ نانومتر (E4/E6) وكذلك دليل الانبات. وقد بلغ دليل الانبات نسبة ١٠٠% بعد ١٤٣ يوم فى الكومات ١ م^{٣} وبعد ٨٦ يوم فى الكومات ٤,٥ م^{٣}، وقد وجد ان هناك ارتباطاً معنويا بين دليل الانبات والاختبارات الاخرى. وقد بينت النتائج المتحصل عليها ان الكمبوست النهائى مطابقا للتصنيف Class A حسب مواصفات كمبوست المخلفات الصلبة وذلك بالنسبة لمحتوى الكمبوست من الميكروبات الممرضة ومحتواه من العناصر الثقيلة. وقد اظهرت النتائج ان الكمبوست الناتج افضل من البيت كبيئة لنمو كل من Cucumber و Vinca.