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Aerobic Municipal Solid Waste Compost Quality According to Different Layers of Composting Bioreactor

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Abstract— Composting is one of the methods of solid waste management (SWM) where the organic component of solid waste stream is biologically decomposed under controlled conditions. A bioreactor tank was designed to contain 59.2 kg of mixed organic municipal solid waste, the organic matter was degraded under aerobic condition for 30 days. The tank was 45 cm in diameter, 130 cm total height and a 0.2 cm wall thickness. Three circular openings with screwed cover having diameter of 12 cm were leveled at (20, 40 and 80) cm respectively to withdraw samples. Temperature, moisture and pH were measured for three layers as process guideline indicators. Maximum temperature ranged between (34.79 to 46.91) ºC. Initial pH value was 6.53, ended within a range of (7.4 to 7.44). Chemical analysis for the composts in the three levels proved that the final C/N ratio ranged between (13.8 to16.1), TOC ended within a range of (17.33% to 25.24 %), final nitrification index (N-NH4/N-NO3) ranged between (0.22 to0.31), final of P% ranged between (0.89% to 1.23%), final of K% ranged between (1.69% to 1.81%) and results of germination index (GI %) ranged between (76.54%, to 88.35%) for three layers respectively. At the close of the experiment results proved that aerobic in-vessel composting could reduce the large amounts of wastes by 40% as a total mass. A satisfactory degree of decomposition was apparent in all levels, and the material was characterized by a pleasant earthy odor, and the obtained compost can be classified as mature compost. In conclusion, the three different layers do not have much effect on the quality indices of the final product.

Keywords— Municipal solid waste (MSW), aerobic composting, organic waste, germination test.

1. Introduction

The term municipal solid waste (MSW) describes the stream of solid waste generated by households, commercial establishments, industries and institutions. MSW consists of everyday items such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint and batteries. It does not include medical, commercial and industrial hazardous or radioactive wastes, which must be treated separately. Large quantities of biodegradable municipal solid waste (BMSW) are generated everyday by households, consumers, industries and commerce [28]. Dumping waste in landfills is a simple method of disposing, but this method can cause other types of environmental issues, such as soil and groundwater contamination due to nutrient leaching into the groundwater and to air that can occur during degradation of putrescible waste. Therefore, alternative methods of processing for disposal or for recycling waste into useful products should be explored [25]. Integration of various processes is a necessity in order to meet high levels of waste diversion and reduce our reliance on land disposal. A relatively large quantity of solid wastes consists of organic materials. Collection and treatment of the organic fraction of MSW can help meet regulatory and other requirements associated with reduction of the quantities of waste reaching landfills. Composting is a relatively simple and cost-effective method of treating organic wastes. In addition, composting offers a number of benefits among which are: increase of the lifespan of the disposal site, reduction of the quantity and quality of leachate produced and gas produced in landfills [17]. Composting decreases the volume and weight of the raw material resulting stable product, which can be widely used in agriculture and horticulture moreover; products can be used widely as an amendment in agriculture, recycling its valuable components: organic matter, N, P and other plant nutrients [9]. Moreover, it seems to increase water holding capacity, soil buffering and cation exchange capacity and finally improves soil porosity. Stable and mature compost can be applied to soil as an organic amendment to improve plant growth and soil fertility, as well as enhancing the function of soil for carbon sequestration. However, the application of unstable and immature compost would fix nitrogen in the soil and restrict plant growth by competing for oxygen in the rhizosphere and releasing toxic substances [5]. An aerobic composting process consumes large amounts of oxygen. During the first days of composting, easily degradable components of the organic materials are rapidly metabolized. The need for oxygen and the production of heat are greatest during the early stages and then decrease as the process continues. If the supply of oxygen is limited, the composting process slows and the process becomes anaerobic (without oxygen). The initial carbon to nitrogen (C/N) ratio is one of the most important factors influencing compost quality [20]. In general, initial C/N ratios of 25–30 are considered ideal for composting [24].During composting, the moisture content (MC) is important for transporting the dissolved nutrients required for the physiological and metabolic activities of microorganisms. The optimum MC depends on the specific physicochemical properties and biological features of the materials being composted [26]. Several researchers have studied the effects of aeration, C/N ratio and MC on the quality of compost, they have focused on one or two influential factors in one layer of composted materials, therefor, the present paper attempts to investigate the main factors affecting the stability and maturity of composted organic MSW and variations influence of aerobic composting quality (C/N, TOC, pH, NPK and GI) in three vertical different layers of a composting vessel (bioreactor).

2. Materils And Methods

2.1 *In-Vessel Composting Tank Design*

The bioreactor tank was designed to contain 59.2 kg of mixed organic solid waste. The tank was 45 cm in diameter, 130 cm total height and a 0.2 cm wall thickness. The tank was provided with false bottom made of perforated steel plate about some 3 inches above the bottom of the tank. Thus, a clear space was provided for catching any drainage liquor, or for introducing air as shown in Fig.1.

Figure 1:Tank and raw materials used in the compositing Process.

Three circular openings with screwed cover having diameter of 12 cm were leveled at (20, 40, and 80) cm above the perforated plate. Two openings (slots) were installed at the top of the tank, one for gas emission and the other slot for introducing special sensors to read temperature and moisture on line using monitoring system every 30 min for 30 days. An opening for leachate collection was made in the bottom of the tank. The digester cell was designed as a one- stage batch system, where the organic matter was degraded under aerobic condition. Day 1 is defined as Jan 20/ 2018; and ended after 30 days on the Feb. 18/ 2018.The treatment process was aerobic static pile system. To control the compost's characteristics a simulated kitchen food waste mixture of potatoes, leaves, carrots, steamed rice, meat, animal manure and garden soil were used as raw materials. Leaves were added as a bulking agent and as a source of nitrogen, while garden soil was added to provide more desired microorganisms [28]. Food waste was segregated at house level and shredded manually into pieces of about 0.5 cm length except for rice, it was cooked. Detailed composition of raw material that were used in the composting operation were shown in Table1.

Table1: Food waste composition

Item	MSW (Kg)
Potato	9.35
Carrot	7.7
Meat	1
Steamed rice	8.5
Soil	10.4
Leaves	2.5
Water	5
Animal manure	14.75
Total	59.2

Food waste was mixed according to Carbon to Nitrogen ratio (C/N) of 25[20]. Samples were taken from the pile in the bioreactor on days 0, 7, 21, and 30 at three different layers (20, 40, and 80) cm for analysis. Results were presented as the mean of the three replicates samples.

2.2 *Analytical Procedure*

2.2.1 Characterization of the composting process (Temperature and Moisture Contents)

The compost temperature and moisture content were measured at regular time intervals throughout the composting period, using on line sensors. The software registered the moisture content and temperature in three different levels through the pile. Signals gathered by thermometric sensors and were converted to digital signals by A/D equipment and transmitted to the computer. The software automatically saved temperature and moisture data of the experimental piles per half an hour. Temperature kept on rising to reach a plateau of 45 C°. To counteract the drying effect of rapidly increasing temperatures that is to keep moisture content within the setting value, an atomizer spray was used to add moisture to the air to control moisture content to a level of (35-45) %. Measurements proceeded until the termination of the composting processes.

2.2.2 Characterization of the compost

a. Determination of Organic Matter (O.M%) and Carbon (C %)

Organic matter was determined using combustion method [3]: Two grams of sample were weighed and dried in an air oven at 105°C for 24hr.The dried sample was weighed to determine dry weight (A). Dried weight (A) was burned in a furnace at 550°C. After cooling, the sample was weighed to measure the ash weight (B).

$$\% \text{ Organic matter}\% = (A-B)/A \times 100 \qquad (1)$$

$$\% \text{ Carbon} = (\% \text{ organic matter})/ 1.8 \qquad (2)$$

b. Determination of N-NH4, N-NO3and phosphorus

The content of nitrogen as ammonium and as nitrate and total phosphorous as P2O5was determined by using Multi Direct photometer for multi-parameter analyses (water test equipment, Lovibond, Germany).

c. pH

Ten grams of each sample were weighed and introduced into Erlenmeyer flasks with100 ml of distilled water. The prepared sample was placed in an auto shaker (Incubator, SI-600R, Korea) for 30 min. pH analysis samples were taken weekly and measured by using a pH meter (Inolab pH 7110 series, Germany) [3].

d. Potassium and heavy metals concentrations

The concentrations of potassium (K) in dried samples were determined using Thermo scientific 900 heavy metals analyzer (Niton (XRF), heavy metals analyzer, Germany). Data were introduced in (ppm) directly.

e. Germination Test

In order to evaluate the final product of compost as plant growing media, the Germination Index (GI) was measured. The germination percentages with respect to the control and root lengths were determined after test was performed for 48 h at 25oC in the dark with 20 radish seeds placed on a 9 cm filter paper (Whatman No. 1) soaked with 4 ml of compost extract and placed in a Petri dish, [6]. The germination test was repeated with deionized water as a control, and with extract of commercial compost (beat moss). The following equations were used to calculate the relative seed germination, relative root growth, and germination index (GI%), according to [36; 41; 29and, 23]:

$$\text{Relative seed germination (\%)} = \frac{\text{Number of seeds germinated in compost extract}}{\text{Number of seeds germinated in control}} \text{ x } 100 \qquad (3)$$

$$Relative\ Root\ Growth\ \% = \frac{Mean\ root\ length\ in\ compost\ extract}{\sqrt{Mean\ root\ length\ in\ control}}\ x\ 100 \qquad (4)$$

$$\text{GI (\%)} = ((\text{Relative seed germination })\text{x}(\text{Relative root growth}))/100 \qquad (5)$$

3. Results And Discussion

3.1 *Mass loss*

The starting weight of 59.2 kg raw material turned to be 23.68 kg as a whole mass through 30 days of composting indicating successful reduction in mass quantities.

3.2 *Temperature*

Temperature followed a typical temperature profile for composting (mesophylic-thermophylic-mesophylic). In each pile-layer the temperature increased from ambient temperature to more than 40 °C within (3-8) days, and showed rapid initiation of the compost process, due to the appropriate C/N ratio besides the process is exothermic. The substrates passed from an initial mesophylic phase (<30 °C) to a thermophylic phase after the 4thday for all layers. Temperature increased up as a result of biological degradation of organic materials in solid waste or other organic matter in early days of composting process. As the organic compounds were degraded, the piles become richer in the more stable compounds which were less accessible to the microorganisms and as a result the corresponding temperature begun to decrease gradually reaching almost ambient temperature. The temperature reached a second mesophylic phase on the (9th - 11th) while the maturation process took place during this last stage of composting as shown in Fig.2.

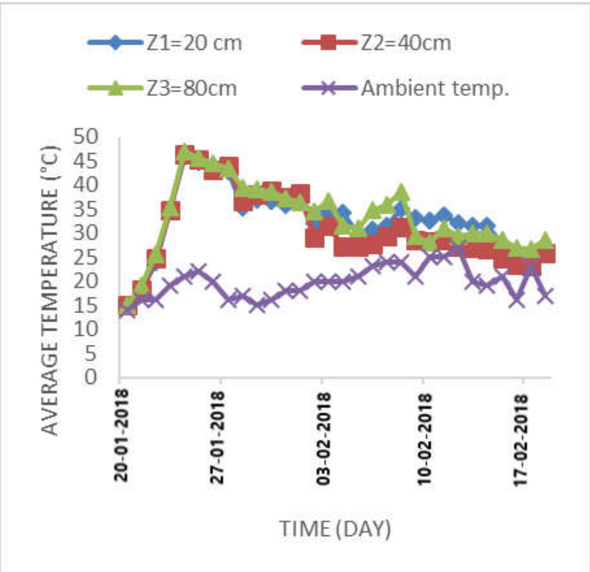

Figure 2: Temperature variations vs. composting processes Time.

Similar temperature profile was observed in related pilot scale bioreactor composting experiments held by, [35; 27; 16; 18; 2; 34 and 11]. Reaching high temperatures may participate actively for accomplishment of compost stability and reduction of retention time in the bioreactor [16]. Finally, the temperature of the pile approached ambient temperature on day (25- 30) th. Elevated temperatures (>40 °C) were maintained in the bioreactor for three continuous days (5th -8th), which is sufficient time for the sanitation of the substrate of pathogenic microorganisms. Many researchers reported that the temperature range for optimal composting is between (52 – 60) ◦C, [16; 19; 2 and 11].

3.3 *Moisture Content (Mc)*

The moisture content tended to decrease due to the combination of high temperature levels and aeration during the thermophylic phase and was controlled by applying water (humidifying) the compost mass. The initial moisture content 63.5 % of the wet weight was reduced in all pile-layers to reach an average moisture content of 40±5% of the wet weight, remaining above the minimum moisture content of 40% suggested by [31] for optimal composting conditions.

3.4 *pH*

Regarding the pH profiles, a slight increase was observed during composting process. In the first weeks of composting the intense microbial activity and organic matter degradation led to the release of ammonia and therefore an increase in the pH occure. Ammonia oxidation to nitrates by the action of nitrobacteria and trapped air lowers high pH and reduces odors, favoring a balanced microbial population [30]. At the end of the composting process, values of pH turned to be in the range of (7.40 to7.44) that was observed in all pile-layers as shown in Fig.3.

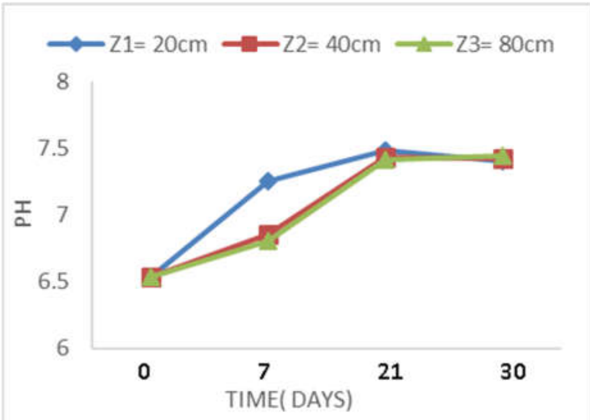

Figure 3: Change in pH value measured during composting

The pH of the mature compost indicates good quality compost that is within the suggested range of (6–8.5) [37]. This finding was closely to the findings of [33;19**]**.

3.5 *Organic Matter Loss and C/N Calculation*

Organic matter is reported in terms of total OM. There is no absolute level of organic matter that is ideal in terms of compost quality, but rather the quantities must be viewed in relation to the age of the compost, its nitrogen content, and its intended use. It is useful for purposes of composting to report the initial and the final OM, as this gives an idea of the extent of decomposition [22].The process which took place in the composting bioreactor resulted in lowering organic matter content percentage (OM %) of the substrate. O.M % of the substrate at the initial stage of composting dropped from 62.34% to (40.24%, 45.88%, 43.66%) for the different layers of (20, 40 and 80) cm respectively as composting process was heading to the end, shown in Table 2.

Table 2: Properties of initial and final compost

O.M%		O.C.%		N%		C/N %	
Initial	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
62.34	Z1=40.24	34.76	Z1=22.35	1.86	Z1=1.38	24.9	Z1=16.1
	Z2=45.88		Z2=25.48		Z2=1.84		Z2=13.8
	Z3=43.66		Z3=24.25		Z3=1.61		Z3=15

Organic Carbon (O.C %) was found to be 34.76% at the initial stage of the composting process and dropped to (22.35%, 25.48%, 24.25%) at three different layers of (20, 40 and 80) cm respectively at the end of the composting process as shown in Table 2. The ratio of C/N is often used to assess the rate of decomposition of compost mixtures; as it may reflect the maturity of the compost. However, caution is necessary before taking any action based only on the C/N ratio. It must be considered that not all the carbon is available for microbial use. Moreover, if nitrogen is lost, C/N ratios may increase during late stages of composting [8], therefore, C/N values must be weighed against observed decomposition traits. Compost may be considered mature when the C/N ratio is approximately 17 or less, [39; 37 and 19]. The content of C was decreased by translating into carbon dioxide and water in all pile-layers. These changes occurred in all layers at the end of the composting process because the molecules degraded by intense microbiological activity during composting became reorganized to form more condensed compounds rich in aromatic components [38].A decrease in nitrogen was expected due to mineralization of nitrogen and transformation to ammonia and later to nitrate. However, this trend cannot be observed, because only a little portion of organic nitrogen is actually transformed [33]. The C/N ratio in all pile-layers was satisfactory (less than 17) as shown in Table 2. Initial substrate had a 24.9 C/N ratio, due to carbon consumption at the end of the process the C/N ratio had decreased to less than 17, for all layers. Yet C/N of layer of level 40 cm was the lowest of the ratios and this might be attributed to the less chance of nitrogen available to mineralization and elevated organic C consumption due to the intermediate location of this layer. C/N data for the whole mass of compost are qualified as good quality compost and thus can be applied in agricultural land. Maintaining C/N ratio after composting is an important factor to determine the value of finished compost as soil amendment for crops. Researchers have suggested various ideal C/N ratios from more than 12 to lower than 25 [32 ;2 and 11].

3.6 *Total Organic Carbon (TOC %)*

The TOC concentration decreased during the process in correspondence with its transformation into CO2 and H2O by microorganisms. Towards the end of the composting process, TOC layer tended to stabilize. The first TOC concentration measurement was 41.21% and finally, was 23.14 %17.33% and 25.24 %, on dry basis, for layers (20, 40 and 80) cm respectively. As can be seen TOC of layer 40 was the lowest and this might be attributed to the highly consumption of organic carbon due to slightly anaerobic condition of entrapped mid layer.

3.7 *Nitrogen Content*

During composting, nitrogen is metabolized mainly to ammonia while the non-soluble complexes of nitrogen decompose to soluble nitrogen forms that are readily available for metabolic activities. Losses in nitrogen gas during composting occur mainly as ammonia but may also occur as nitrogen and nitrates oxides [15]. On the other hand, in terms of dry weight, there is an increase in total nitrogen concentration due to the mineralization of organic matter and consequent loss of weight in the mass being composted through losses of CO2 and H2O [4]. Significantly high losses of N occurred during the composting process. The degree of stability of the compost is also strictly related to the nitrification index (N-NH4/N-NO3) as shown in Table3.

Table 3: Nitrification index (NH4--N/ NO3-N)

Compost mg/Kg	Initial	Final		
		Z1= 20cm	Z2= 40cm	Z3= 80cm
NH_4^--N	440.45	205.55	340.55	432.55
NO_3^+-N	1295.44	934.32	1418.95	1395.32
NH_4^--N/ NO_3-N	0.34	0.22	0.28	0.31

Higher N content (1.9%) was found in the compost which contribute to the reduction of the nitrification index (N-NH4/N-NO3) during compost maturation and can be considered as an indicator of a high degree of compost stability [7; 40; 1; 12; 19; 2 and 11].

3.8 *Nitrogen, Phosphorous and Potassium (NPK)*

Layers of NPK value in the finished compost are also important in determining the quality of compost, for those elements are essential nutrients for plant growth [21] reported that the nitrogen, phosphorous and potassium (NPK) contents for compost should be more than 1% each. Layer of level 40 cm had the higher N% measurement after composting process that was1.84% and shown in Table 4

Table 4: P and K percentages in feed waste and in final composts

Item	Initial %	Final %			(TMEC,2002)
		Z1=20 cm	Z2=40 cm	Z3=80 cm	
P%	1.56	0.89	1.12	1.23	(0.56 -1.56)
K%	1.66	1.69	1.72	1.81	(0.62-1.22)

The amount of P% in the original pile was 1.56% and lowest was 0.89% at layer 20 cm; Phosphorous reduction may be attributed to consumption of phosphoric compounds in cell growth and reduction in total mass. The amount of K values in the original pile was 1.66% increased to a highest value of 1.81% at layer 80 cm. According to the aforementioned literatures and the data of produced compost analysis it appears to be satisfactory for plant growth. The variation in concentration might be due to anaerobic conditions in intermediate layers.

3.9 *Germination Test*

Maturity of compost may be evaluated with the use of the cress seed germination bioassay, which is sensitive to excessive salinity or the presence of phytotoxic simple organic acids or phenol compounds [10;14]. One of the most significant germination tests is that reported by [43;42], and many later tests were developed from this. The results of germination tests were shown in Table 5.

Germination index (GI%) was 76.54%, 83.7% and 88.35% for layers of levels (20, 40, and 80) cm respectively. This finding was closely to the findings of [2] (GI %) of 84.8% and [11] reported (GI %) 77.4%, which is better than the suggested value of 60% for cress reported by, [13]. Table6 gives values for very mature, mature and immature composts [37].

Table 5 : Outcomes of germination test

Item/ parameter	Control test	Final Compost test			Compost extract of Commercial compost
		Z1=20cm	Z2=40cm	Z3=80cm	
Total seeds	15	15	15	15	15
Germinated seeds	15	13	14	14	11
Mean root length (cm)	1	0.87	0.94	0.94	0.71
Relative seed germination (%)	1	86	93	93	73
Relative root growth%	-	89	90	95	65
Germination index (%)	-	76.54	83.7	88.35	47.45

Table 6 : Compost maturity Indices [37].

Method	Units Rating		
	Very Mature	Mature	Immature
NH4- : NO3-N Ratio	< 0.5	0.5 - 3.0	> 3
Total NH3-N ppm, dry basis	< 75	75 - 500	> 500
%Seed Germination	> 90	80 - 90	< 80
Plant Trials % of control	> 90	80 - 90	< 80

According to [37] the obtained compost can be classified as mature compost.

4. CONCLUSIONS

1. Composting provides a critical step in the treatment of MSW as mass reduction. The residuals after composting are about 40 % of the original weight.

2. The temperature of all layers elevated above 40 °C and were maintained in the bioreactor for (3-8) days, which is sufficient time for the sanitation of the substrate and the destruction of pathogenic microorganisms that might be existed.

3. Final pH levels readings were (7.40, 7.42, and 7.44) for the three layers respectively that were within the recommended range of (6–8.5).

4. The amount of the C/N ratio was 24.9 and turned to be (16.1, 13.8, 15) for the three layers respectively at the end of the process and this is due to carbon consumption. C/N data were still within the recommended range approximately 17 or less.

5. The acquired ratios of nitrification index (N-NH4/N-NO3) values were 0.34 decreased to 0.22, 0.28 and 0.31, at three different levels (20, 40, and 80) cm respectively. Biomass with lower than 0.5 nitrification ratio is considered as mature compost.

6. The amount of nitrogen percentage (N%) values was 1.86% decreased to 1.38%, 1.84% and 1.61%, at three different levels (20, 40, and 80) cm respectively, which proved that all to be satisfactory where C/N values were within the limits.

7. The amount of phosphorous percentage (P %) values were 1.56% and decreased to 0.89%, 1.12% and 1.23%, for three different levels (20, 40, and80) cm respectively. That is still within the recommended range of (0.56 -1.56).

8. The amount of potassium percentage (K %) values were 1.66% increased to 1.69%, 1.72% and 1.81% at three different levels of (20, 40, and 80) cm respectively. That is still within the recommended range (0.62-1.22).

9. NPK of the compost in all layers of the end-product appeared to be sufficient for plant growth as were proved in germination test.

10. The results of germination test; values of germination index (GI %) were 76.54%, 83.7% and 88.35%, for three different levels of layers (20, 40, and 80) cm respectively. The obtained compost can be classified as mature compost. This stabilized compost can be considered very satisfactory for agricultural use.

11. A satisfactory degree of decomposition was apparent in all levels, and the material was characterized by a pleasant earthy odor. The obtained compost can be classified as mature compost.

In conclusion, the obtained compost from the three levels have similar properties that do not have much effect on the quality indices of the final product.

5. RECOMMENDATIONS

1. Encouraging recycling efforts, by giving incentives and tax exemptions where appropriate. Encourage public-private partnerships for instance giving licenses to private waste collectors.

2. Encouraging private sector to set up more recycling industries for recycling plastic and metallic solid waste. The private sector should also come up with strategies of reusing and conversion (composting) organic waste.

3. It is recommended that segregation for MSW should be carried out at the household level in terms of achieving highest efficiency for compost production.

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6. NOMENCLATURE

C/N =carbon to nitrogen ratio.

DM =dry matter.

GI =germination index.

Mc =moisture content.

MSW =municipal solid waste, (kg/capita. day).

BMSW = biodegradable municipal solid waste

NPK= nitrogen, phosphorus and potassium content.

OM =organic matter.

SWM =solid waste management.

TMECC =test methods for the examination of composting and compost.

TOC =total organic carbon

نوعية السماد العضوي الناتج عن المخلفات الصلبة البلدية تبعاً للطبقات المختلفة لسماد المفاعل البايولوجي

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الخلاصة – أن التسميد الهوائي هو أحد طرق إدارة النفايات الصلبة ((SWMاذ يتم التحلل البايولوجي للمادة العضويةالمتوفرة في النفايات الصلبة في ظروف مسيطر عليها. تم تصميم خزان مفاعل حيوي لاحتواء 59.2 كيلوجرام من النفايات الصلبة العضوية المختلطة. تحللت المادة العضوية تحت ظروف الهوائية استمرت لمدة 30 يومًا. كان قطر الخزان 45 سم و الإرتفاع الكلي 130 سم وسمك الجدار 0.2 سم. تم اعداد فتحات دائرية بغطاء محكم وبقطر 12 سم على مستويات (20 ، 40 و 80) سم من مستوى قاعدة الخزان لسحب العينات المأخوذة للفحص .تم قياس درجة الحرارة والرطوبة ودرجة الحامضية لثلاث طبقات كمؤشرات لنجاح العملية. تراوحت درجة الحرارة العظمى بين (34.79 إلى 46.91) درجة مئوية. كانت قيمة الاولية للرقم الهيدروجيني 6.53 ، وتراوحت القيمة النهاية بين (7.4 الى 7.44). أظهرت النتائج النهائية أن نسبة C / N تراوحت ما بين (13.8 إلى 16.1) ، وأظهرت النتائج النهائية للكاربون العضوي الكلي) (TOC تراوحت مابين (17.33% و 25.24%) ، وتراواح معامل النترجة النهائي ((N-NO3 / N-NH4بين (0.22 و 0.31)، وأظهرت النتائج النهائية للفسفور) (P%تراوحت مابين (0.89% و 1.23%) ، وأظهرت النتائج النهائية للبوتاسيوم) (K%تراوحت مابين (1.69% و 1.81%) .وكانت نتائج أختبار معامل الاستنبات (76.54) (GI%٪،83.7 ٪ و 88.35٪)، لثلاث طبقات على التوالي من الادنى الى الاعلى . وبانتهاء عملية اعداد السماد العضوي يمكن الاستنتاج بوضوح الى تفوق العملية في خفض كمية النفايات الى مايقارب ال 40% من الوزن الابتدائي. وان المادة الناتجة تميزت برائحة مقبولة مشابهة لرائحة الارض بالتالي فيمكن ان يصنف السماد الناتج تحت درجة سماد ناضج. وبشكل عام لم يكن هناك تاثير ملحوظ للارتفاعات المتعاقبة على دلائل نجاح العملية وبالتالي لم يتأثرنوع السماد الناتج باختلاف مستويات الارتفاع في الخزان.

الكلمات الرئيسية – النفايات الصلبة البلدية، التسميد الهوائي، النفايات العضوية، معامل الاستنبات.