Study on Composting of Sawdust by Rapid Method

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Abstract

This study was aimed to assess the effect of effective microorganisms (EM) application on the composting of sawdust with cow dung and to evaluate the quality of compost. Four treatment piles were investigated in this study, in which two piles (sawdust and cow dung ratio of 1:1 and 2:1) were applied with EM and another two piles (sawdust and cow dung ratio of 1:1 and 2:1) were treated without EM, as control. Each treatment was carried out once with a duration of 150 days of composting. Changes in temperature, pH, total organic carbon, height of compost piles, moisture content and C/N ratio showed that decomposition of organic matter occurs during 120 days of composting in EM treatments and 150 days in control treatments. It was also found that the composts produced from sawdust and cow dung ratio of 2:1 possessed better characteristics and higher nutrient values than those produced from raw materials ratio of 1:1. The application of EM in composting increased the macro and micronutrient contents of compost. The following parameters support this conclusion: compost applied with EM has more N (0.63%), P (0.15%) and K (0.53%) contents compared to compost without EM in which N (0.56%), P (0.12%) and K (0.49%). This study suggested that the application of EM is suitable to shorten the composting process and increase the mineralization of compost. The final resultant composts indicated that they were in the range of the matured level and can be used without any restriction.

Keywords: **effective microorganisms, composting process, C/N ratio, macronutrient, micronutrient**

Introduction

In Myanmar, enormous quantities of sawdust are produced annually by sawmills and economical disposal is a problem of growing concern to the wood industries. Composting is a viable process of treating solid waste for beneficial use and destroying pathogens, diseases and undesirable weed seed. By properly managing air, moisture and nutrients, the composting process can transform large quantities of organic waste into compost in a relatively short time. The objectives of the study were:

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1. to produce compost from sawdust and cow dung by the application of Effective Microorganism(EM);
2. to assess the effect of EM application on the composting process by conducting with and without EM treatments;
3. to evaluate the quality of compost which are produced by varying the amount of sawdust and cow dung ; and
4. to analyze the characteristics of raw materials and compost samples such as nitrogen content, phosphorus content, potassium content, calcium, magnesium and sulfur contents, total organic carbon content, moisture content, pH, and C/N ratio.

Materials and Methods

Experimental Set up

The experiments were conducted at the Laboratory of Department of Industrial Chemistry, West Yangon University, during the year 2014, taking five months (from August 1 to December 31).

Four different treatment methods were studied: treatment T_1 - composting of sawdust and cow dung (1:1) with EM; treatment T_2 - composting of sawdust and cow dung (2:1) with EM; treatment C_1 - composting of sawdust and cow dung (1:1) without EM and treatment C_2 - composting of sawdust and cow dung (2:1) without EM.

Sources of Raw Materials

Sawdust was collected from Shwe Mann Saw Mill in Insein Township, Yangon Region. Cow dung was collected from the rice fields adjacent to the West Yangon University. The concentrated EM (Effective Microorganisms) was obtained from Vegetables and Fruits Research Development Center (VFRDC), Ministry of Agriculture and Irrigation, Ye-Mon, Yangon Region. Rice rinse water was collected from food shops of West Yangon University.

Preparation of Compost Piles

Sawdust was used as the main material for composting together with cow dung. The composting containers were placed at the shaded area in the Laboratory. In this experiment, four different compost piles were prepared--compost piles with EM (T_1 and T_2) and compost piles without EM (C_1 and C_2) for control. The mixtures used for all piles were arranged with the ratio as follows: 50 % sawdust and 50 % cow dung, in which 7.5kg of sawdust was mixed with 7.5kg of cow dung for T_1 and C_1, and 66% sawdust and 33% cow dung in which 10kg of sawdust was mixed with 5kg of cow dung for T_2 and C_2.

In each compost pile, there were five alternate layers of sawdust and cow dung. For the treatments T_1 and C_1, the bottom, middle and top layers were filled with 2.5kg each of sawdust and the two sawdust layers were sandwiched with 3.75kg each of cow dung. For the treatments T_2 and C_2, the bottom, middle and top layers were filled with 3.3kg each of sawdust and the two sawdust layers were sandwiched with 2.5kg each of cow dung.

Preparation of EM Solution

The commercial concentrated EM was kept away from sunlight and used for the preparation of EM Activated Suspension (EMAS). EMAS is actually an activated EM suspension in a mixture of molasses (jaggery) and rice rinse water (which provide the minerals for the multiplication of microorganisms).

For the activation of EM, 1 part of concentrated EM, 1 part of molasses (prepared by dissolving 400g of jaggery in 1 Litre of pure water) and 8 parts of rice rinse water (obtained by rinsing rice and water in the volume ratio of 1:3 for the first time). This solution was then stored for three to five days in an air tight plastic bottle for fermentation. The built up gas was released once a day. Finally, the EM solution to use in composting was prepared by mixing 1 part of EMAS with 4 parts of water.

Composting Process

Throughout the whole composting period by frequent checking, the moisture content of compost piles were maintained at 50-60% by the addition of EM solution in the treatments T_1 and T_2 , and water in the treatments C_1 and C_2. The compost piles were turned at 2 days interval to maintain porosity, to improve aeration, to speed up the activities of microorganisms and to ensure uniform decomposition.

The temperature of compost piles were measured daily with a thermometer at random depths. The height of compost piles were also recorded daily. Decomposition was completed when the pile cooled off.

Harvesting Process

The composts obtained from T_1 and T_2 were harvested after four months of composting period when the temperature of piles fall below ambient temperature. On the other hand, those obtained from C_1 and C_2 were harvested after five months of composting period. When the composts were ready to harvest, it was kept without applying EM or water for five days to make the compost easy for shifting. The harvested composts were spread on the plastic sheets for 3 days to reduce moisture content to about 35%. The dried compost samples were weighed and stored in air tight plastic bags.

Physicochemical Analysis

The physical characteristics (such as moisture content and pH) of sawdust, cow dung and the compost samples were determined at the Laboratory of Department of Industrial Chemistry, West Yangon University. The chemical characteristics (such as carbon to nitrogen ratio, nitrogen content, phosphorous content, potassium content, calcium, magnesium and sulfur contents, and total organic carbon content) of sawdust, cow dung and four compost samples were analyzed at the Laboratory of Department of Land Use Division, Myanmar Agriculture Service (MAS), Ministry of Agriculture and Irrigation, Yangon Region.

Results and Discussion

Weight of Compost

It was found that the complete conversion of all the sawdust into compost took 4 months (from August 1 to November 30, 2014) for the treatments with EM (T_1 and T_2). On the other hand, the composting process took 5 months (from August 1 to December 31, 2014) for the treatments without EM (C_1 and C_2). The matured composts were black, light in weight and free from bad odor. With an input of 15 kg of raw feedstock in each treatment, 7.9 kg, 7.8 kg, 7.7 kg and 7.8 kg of compost were produced as shown in Table (1). The results showed that the weight of composts produced from all the different treatment methods were almost the same. Since the average moisture content of raw materials (36 % w/w) and that of compost (35 % w/w) were nearly the same, it can be assumed that half of reduction in weight was achieved at the end of decomposition process.

Table (1) Weight of Raw Feedstock and Compost Products

Treatments	Weight of Raw Feedstock (kg)			Weight of Composts (kg)
	Sawdust	Cow Dung	Total	
T_1	7.5	7.5	15.0	7.9
T_2	10.0	5.0	15.0	7.8
C_1	7.5	7.5	15.0	7.7
C_2	10.0	5.0	15.0	7.8

T_1- Composting of sawdust and cow dung (1:1) with EM

T_2- Composting of sawdust and cow dung (2:1) with EM

C_1- Composting of sawdust and cow dung (1:1) without EM

C_2- Composting of sawdust and cow dung (2:1) without EM

Changes in Height of Compost Piles

Changes in height of piles during the composting process (from 0 to 165 days) were recorded every 15 days. The changes in height of piles were very significant for the treatments with EM (T_1 and T_2) during 20 days and 100 days and the complete decomposition was achieved in 4 months. For the treatments without EM (C_1 and C_2), the gradual decrease in height of piles were noted up to 165 days and it took 5 months to get complete decomposition. The height of piles reached a minimum of 5.9 and 5.7 inches in T_1 and T_2 and 6.3 and 6.0 inches in C_1 and C_2. The changes in height of piles during the composting process are indicated in Figure (1).

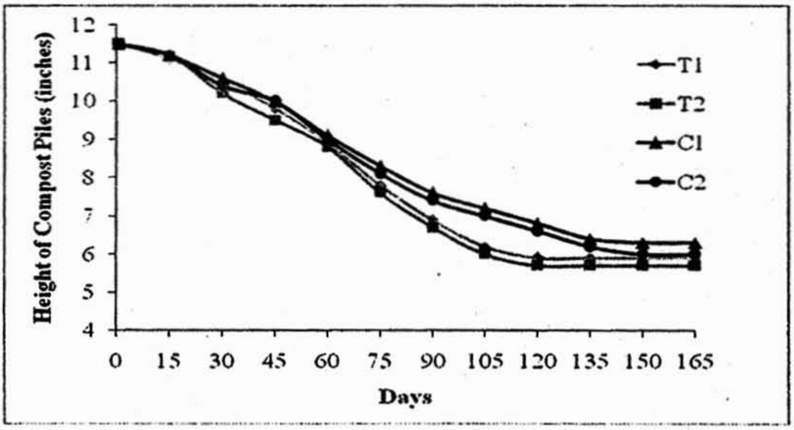

Figure (1) Changes in Height of Compost Piles during Composting

The temperature pattern showed that there is a rapid progress from the initial mesophilic phase to the thermophilic phase for all the different treatment methods. The temperature profiles of four different composting treatment methods are shown in Figure (2). All treatment methods showed an increase in temperature right after composting started.

On the 15th day, the temperature rose from 28°C to 37°C for the treatments with EM ($T_1$and T_2) and from 28°C to 34°C for the treatments without EM ($C_1$and C_2). The piles treated with EM reached the highest peak values of 48°C on the 30th day and also the piles treated without EM reached the highest peak values of 42°C on the 30th day. These showed that all the composting treatments reached thermophilic temperature (>40°C).

The thermophilic phase lasted for 45 days for treatment $T_1$and T_2, whereas treatment $C_1$and C_2 lasted for 60 days. As shown in Figure (2), the temperature gradually decreased afterwards and finally stabilized near the ambient temperature at 90-105 days for composting treatment $T_1$and T_2 and 150-165 days for composting treatment $C_1$and C_2.

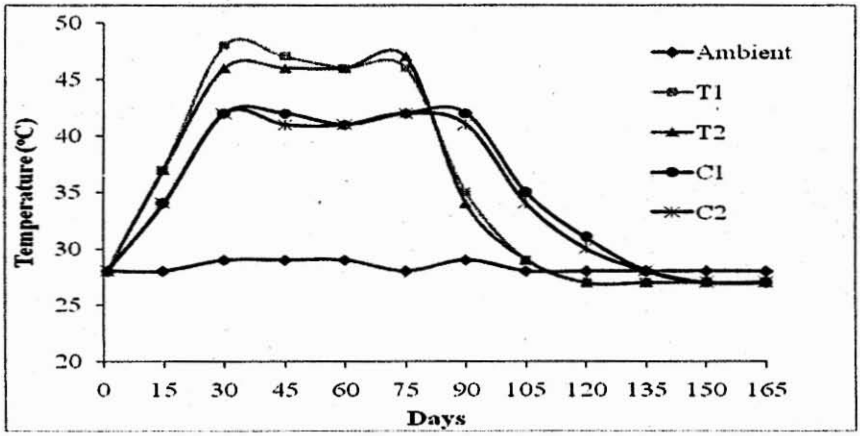

Figure (2) Temperature Changes during Composting Process

Physicochemical Characteristics of Compost Piles at the Start of Composting and Matured Compost Samples

Physicochemical characteristics of compost piles at the start of composting and those of matured compost samples are shown in Tables (2) and (3). One of the often used parameters to assess the rate of decomposition in the composting process is the C/N ratio, since it can reflect the maturity of the compost. Tables (2) and (3) showed the decrease in C/N ratio in all treatments due to the mineralization of organic matter. The initial C/N ratio for T_1 and C_1 were 30.0, while for T_2 and C_2, they were 35.0. The final values of C/N ratio were 13.9 for T_1, 14.6 for T_2, 17.3 for C_1 and 18.5 for C_2. These results agreed with those of other researches, such as Makan (2012), Roca-Peréz (2009) and Tumuhairwe (2009). A C/N ratio of less than 20 is considered as mature and can be used without any restriction.

The Total Organic Carbon (TOC) concentration declined for all treatments. The initial values of TOC were 46.7% for T_1 and C_1, and 49.3% for T_2 and C_2. The final values of TOC were 17.3% for T_1, 19.9% for T_2, 23.4% for C_1 and 25.2% for C_2. It was found that the results fall within the range of literature value. According to ICRISAT (2006), the moisture content of compost ranges between 32 and 66%. The results showed that the moisture content of all compost were 34-35%.

The initial values of pH were 7.2 for T_1 and C_1, and 6.9 for T_2 and C_2. The final values increased to 7.8 for T_1 and C_2, and 7.4 for T_2 and C_1. These values indicated that the compost products had good quality since the values were within the suggested range of 6–8.5 which was reported by Fogarty (1991).

Table (2) Physicochemical Characteristics of Compost Piles at the Start of Composting

Parameters	Compost Pile (T_1)	Compost Pile (T_2)	Compost Pile (C_1)	Compost Pile (C_2)	Literature Value***
C/N Ratio*	30	35	30	35	25-35
Total Organic Carbon*(%w/w)	46.7	49.3	46.7	49.3	25-80
Moisture Content**(% w/w)	38.4	32.5	38.8	32.9	32-66
pH**	7.2	6.9	7.2	6.9	6.0-7.5

* The data were determined at the Laboratory of Department of Land Use Division, Myanmar Agriculture Service (MAS), Ministry of Agriculture and Irrigation.

**The data were measured at the Laboratory of Department of Industrial Chemistry, WYU.

*** Dalzell, 1987; ICRISAT, 2006; Makan, 2012; Fogarty, 1991.

Table (3) Physicochemical Characteristics of Matured Compost Samples

Parameters	Compost (T_1)	Compost (T_2)#	Compost (C_1)	Compost (C_2)	Literature Value***
C/N Ratio*	13.9	14.6	17.3	18.5	10-20
Total Organic Carbon*(% w/w)	17.3	19.9	23.4	25.2	15-50
Moisture Content**(%w/w)	34.4	34.6	34.5	34.8	32-66
pH**	7.8	7.4	7.4	7.8	6.0-8.5

\# The most suitable condition

* The data were determined at the Laboratory of Department of Land Use Division, Myanmar Agriculture Service (MAS), Ministry of Agriculture and Irrigation

**The data were measured at the Laboratory of Department of Industrial Chemistry, WYU.

*** Dalzell, 1987; ICRISAT, 2006; Makan, 2012; Fogarty, 1991

Macronutrients of Matured Compost Samples

The primary and secondary macronutrients of compost samples are indicated in Table (4). It was found that the nutrient contents of samples in T_1 and T_2 were significantly higher than those in C_1 and C_2. Specifically, the primary macronutrients (N, P, K contents) of all samples fall within the range of literature value. For secondary macronutrients, Ca content only in T_2 fall within the literature range and that in T_1, C_1 and C2 were found below the range.

Table (4) Macronutrients of Compost Samples

Macronutrients	Compost (T_1)	Compost (T_2)#	Compost (C_1)	Compost (C_2)	Literature Value**
Primary Macronutrients*					
N (%)	0.61	0.63	0.48	0.56	0.40-1.61
P (%)	0.13	0.15	0.11	0.12	0.10-1.02
K (%)	0.51	0.53	0.47	0.49	0.15-1.73
Secondary Macronutrients*					
Ca (%)	0.97	1.00	0.93	0.94	1.00-7.61
Mg (%)	0.34	0.35	0.33	0.34	0.09-0.60
S (%)	0.02	0.02	0.01	0.01	-

\# The most suitable condition

* The data were determined at the Laboratory of Department of Land Use Division, Myanmar Agriculture Service (MAS), Ministry of Agriculture and Irrigation

** ICRISAT (2006)

Conclusion

All the parameters measured indicated that the decomposition processes took place in all the different treatment methods. Changes in temperature and pH showed that the decomposition of organic matter occurred during the 120 days of period for the treatments with EM and 150 days of period for the treatments without EM. These results proved that the application of EM speeded up the composting process. The decrease in C/N ratio also showed that an organic compound was being consumed by microorganisms. It was also found that the composts produced from sawdust and cow dung ratio of 2:1 possessed better characteristics and higher nutrient values than those produced from raw materials ratio of 1:1. The application of EM in compost increased the macro and micronutrient contents. The following parameters support this conclusion: compost applied with EM had more N, P and K content (0.63%, 0.15%, and 0.53%) compared to compost without EM (0.56%, 0.12%, and0.49%). However, for Mg and S, there is no significant difference between treatments. . The final resultant composts indicated that they were in the range of the matured level and can be used without any restriction.

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