Preparation and Characterization of Leaf Compost

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Abstract

The application of organic wastes as compost to soil is considered as a good management practice in any agricultural production system because it improves plant quality and soil fertility. In the present work, leaf compost (organic fertilizer) was prepared from organic wastes. The organic waste materials (cow dung and dry leaves) that enhance the suitability for application to the soil as a fertilizer or soil conditioner were selected for composting. Physicochemical properties of these waste materials were determined by standard methods. The elemental contents of the waste materials were also analyzed by EDXRF and AAS methods. The leaf compost was made from these wastes by open heap layering method. The variation of the temperature during composting process was recorded and the physicochemical properties of organic fertilizer were qualitatively and quantitatively characterized by conventional methods and modern techniques such as EDXRF and AAS. This study indicated that macronutrients, micronutrients and trace elements needed for plants and suitable amount of organic matter for good soil fertility were present in prepared leaf compost (organic fertilizer).

Keywords: Leaf compost, Organic fertilizer, Macronutrients, Micronutrients, Composting.

INTRODUCTION

Myanmar is the agricultural country and its economy is based on agriculture. Since many years, farmers have used chemical fertilizer for enhancing the growth of plants. But the continuous use of these chemical fertilizer leads to loss of soil fertility that has adversely affected agricultural productivity and causes soil degradation. Hence it has become necessary to reduce the use of chemical fertilizers in order to lessen the pressure on the environment due to irresponsible agricultural practices. So, the role of using organic fertilizer is important to reduce the application of chemical fertilizer. The use of organic manure or compost as organic fertilizer is currently being advocated as option for improving soil fertility conduction for poor farmers. Composted organic material is being applied on agricultural fields as an amendment to provide nutrients and chemical properties of the soil. The application of composted materials as a fertilizer source not only provides essential nutrients to plants, it also improves soil quality and effectively disposes of waste (Hussain, 2002). Composting is the process by which various aerobic microorganisms decompose raw organic material to obtain energy and material they need for growth and reproduction. The end product of this decomposition is a stable humus-like product called compost (Robert, *et al*., 2000).

During composting, microbes break down organic compounds to obtain energy to carry on their life process and acquire nutrients to sustain their populations. Carbon provides both an energy source and the building block of microbial cells. Nitrogen is necessary for cell growth and function (Chen, *et al*., 2011). In this study, organic waste materials (cow dung and dry leaves) were selected for composting since their properties as carbon and nitrogen sources. These waste materials can be easily available in farmer's farm. Besides, by recycling these

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wastes into useful products may solve the environmental problem. Cow dung has been used for centuries as a fertilizer for farming. It can improve the soil structure (aggregation) so that the soil holds more nutrients and water and therefore becomes more fertile. Cow dung also encourages soil microbial activity which promotes the soil's trace mineral supply, improving plant nutrition (Bokhtia and Sakurai, 2005). But, if animal manure is applied, it should have matured for some times, otherwise it might damage the plants. Composting animal manure makes it a better fertilizer (FAO, 2010). Dry leaves are a source of organic fertilizer and the highest value for organic carbon, total nitrogen and potassium (Haque,2000). Effective microorganism (EM) was also used in the composting process as an inoculant to increase the microbial diversity. It contains selected species of microorganisms mainly of lactic acid bacteria, yeast, photosynthetic bacteria, smaller quantities of fermenting fungi and other types of microorganisms. EM is used for initiating beneficial biological function such as composting and degradation of organic matter (Higa, 2000).The aim of the present work is to recycle the organic wastes (cow dung and dry leaves) into useful compost (organic fertilizer) and to analyze this organic fertilizer.

MATERIALS AND METHODS

Sample Collection

Cow dung was collected from Yankin Township, Yangon Region and dry leaves were collected from University of Yangon campus. Cow Dung was dried in air and ground to prepare compost.

Preparation of Leaf Compost (Organic Fertilizer)

In this work, the organic waste materials (cow dung and dry leaves) were used for composting. The pile (approximately 3m length, 1.5m width and 1m height) was made for the preparation of compost (organic fertilizer) by open heap layering method. Firstly, dry leaves were loosely spread on the bottom of the pile for the foundation layer. The compost heap was made by basic layers. First layer was made by dry leaves. This layer was 25cm thick of the sides. The second layer was made by cow dung over the first layer. Then EM solution (EM: water = 1:1 v/v) was sprinkled to attain adequate moisture content. These two layers were made repeatedly until the pile was full of compost making materials. The top of pile was covered with plastic sheet. Temperature of the mixture was measured two times daily and average of the temperature was recorded. In the case of composting, the highest temperature 54℃ was observed only at 19 – 21 days and then dropped to ambient temperature. When white fungus appeared on the surface, the pile was turned over. After 45 days, compost making materials became black and mature compost that is ready to be used was obtained.

Analysis of Organic Waste Materials and Prepared Leaf Compost (Organic Fertilizer)

The organic waste materials and prepared compost (organic fertilizer) were subjected to physical and chemical analyses using the following conventional and modern techniques. The pH of the sample was determined by pH meter and the moisture content was determined by oven drying method. The organic carbon content and the organic matter content were determined by Walkley and Black's dichromate digestion method. The total nitrogen content was determined by Kjeldahl digestion method. The C/N ratio was calculated from measured values of organic carbon and total nitrogen contents. The total P_2O_5 was determined by UV-visible spectrophotometer. The K_2O of organic fertilizer were determined by Flame photometric method. The concentrations of Ca, Mg, Mn, Fe, Zn and Cu were determined by Atomic Absorption Spectrometry. The content of sulphur was determined by turbidity method.

The relative abundance of elements in the sample was determined by Energy Dispersive-X-ray Fluorescence Spectrometer (EDXRF).

RESULTS AND DISCUSSION

Analytical Assay of Organic Waste Materials

This research mainly concerned with the preparation of leaf compost (organic fertilizer) from organic waste materials (cow dung and dry leaves) by using composting method. In Myanmar, traditionally cow dung has been used as a fertilizer for farming. It can improve the soil structure and chemical properties of soil. Cow dung is one of the organic fertilizers, but fresh dung has a disagreeable odor, high ammonia levels that may burn plants, and may contain excess salt. It will heat naturally, killing many microbes and weed seeds. So, the manure should be mixed with high carbon material for rapid aerobic composting (FAO, 2010).

Dry leaves as mulch break down more quickly and can decompose easily. As organic mulches decompose, they release valuable nutrients for use by plants. It is the main reason of using cow dung and dry leaves as raw materials for composting. Before preparing the organic fertilizer, some physiochemical properties of these organic wastes were determined. The data are shown in Table 1. It indicated that the pH values of waste materials were suitable to prepare the organic fertilizer. In cow dung, 1.125 % of N, 0.752 % of P_2O_5, 1.102 % K_2O and 30.124 % of total carbon were observed. It was also found that 3.361 % Nand 0.463 %P_2O_5, 0.753 % K_2O and 36.251 % of total carbon were present in dry leaves.

Table 1. Some Physicochemical Properties of Organic Waste Materials

Parameter	Organic Waste Materials	
	Cow Dung	Dry Leaves
pH	7.91	6.22
Moisture (%)	12.538	9.257
Total N (%)	1.125	3.361
Total P_2O_5 (%)	0.752	0.463
Total K_2O (%)	1.102	0.753
Total Carbon (%)	30.124	36.251

Analysis of Organic Waste Materials by EDXRF

The relative composition of elements in cow dung and dry leaves are shown by EDXRF spectra represented in Figure 1 and Figure 2. Each spectrum indicated that the relevant elements needed for the plants such as Ca, Fe, Zn, K, S, Cu and Mn were present in cow dung and dry leaves. Cow dung contained the highest silicon content and Ca is most abundant in dry leaves. Relative abundance of elements in organic waste materials (cow dung and dry leaves) is given in Table 2.

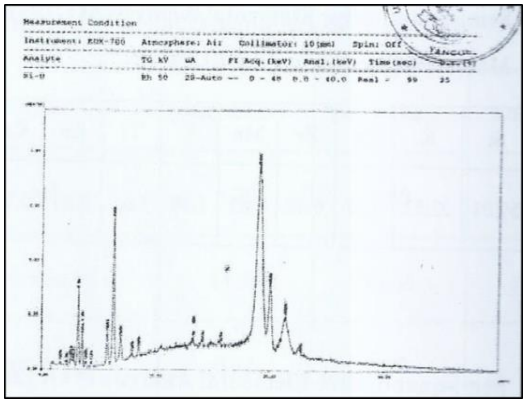

Figure 1.EDXRF spectrum of cow dung

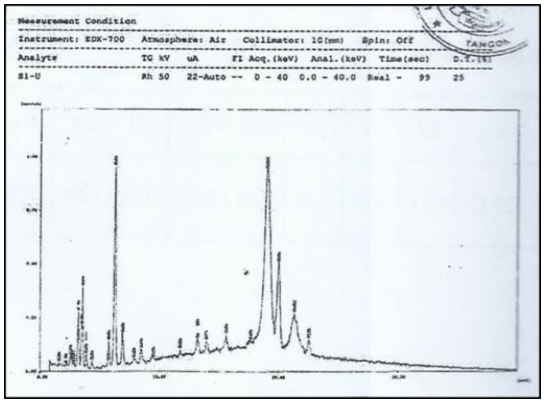

Figure 2. EDXRF spectrum of dry leaves

Table 2. Elemental Analysis of Organic Waste Materials by EDXRF

Elements	Relative abundance (%)	
	Cow Dung	Dry Leaves
Si	43.700	7.096
K	18.458	19.686
Ca	16.666	57.249
Fe	11.742	8.363
Al	2.794	-
Ti	1.965	0.459
S	1.300	3.522
Mn	1.576	3.185
P	1.208	0.057
Zn	0.157	0.240
Sr	0.123	0.102
Cr	0.073	-
Rb	0.072	-
Zr	0.064	-
Cu	0.058	-
V	0.043	-

Elemental Analysis of Organic Waste Materials by AAS

Concentrations of some metals in waste materials (cow dung and dry leaves) are given in Table 3. The most common element contents in cow dung and dry leaves were calcium (18.32 ppm, 16.17ppm), magnesium (7.925ppm, 7.625ppm), manganese (1.312ppm, 2.530ppm), copper (0.054ppm, 0.061ppm) and zinc (0.078ppm, 0.083ppm) respectively. Due to the presence of sufficient amount of macronutrients and micronutrients in organic waste materials, these were chosen to use in the preparation of organic fertilizer.

Table 3. Elemental Contents of Organic Waste Materials by AAS

Elements	Content (ppm)	
	Cow Dung	Dry Leaves
Ca	18.32	16.17
Mg	7.925	7.625
Mn	1.312	2.530
Cu	0.054	0.061
Zn	0.078	0.083

On the Aspect of Preparation of Leaf Compost (Organic Fertilizer)

Temperature is the key parameter determining the success of composting process. The temperature profile of composting pile is shown in Table 4. During the composting process, temperature of composting pile was measured daily. The daily temperature of compost was recorded up to 45 days. In the case of composting, temperature of compost began at 30℃ and then the temperature gradually increased to 54℃ at 19- 21 days. The increase in temperature during the composting process was caused by the heat generated from the respiration and decomposition of sugar, starch and protein by the population of microorganisms. The increment of temperature is a good indicator that there is microbial activity in the compost pile, as a higher temperature denotes greater microbial activity (Robert, *et al*., 2000). Then the temperature dropped gradually again to reach 28℃ at 45 days. The temperature parameter showed that the decomposition of organic matter occurs during 45 days period. After 45 days, the compost became mature to be used.

Table 4. Variation of Temperature during Composting Process

Day	Temp (˚C)	Day	Temp (˚C)
1	30	24	52
2	30	25	50
3	33	26	50
4	34	27	49
5	34	28	48
6	35	29	45
7	36	30	38
8	37	31	37
9	39	32	36
10	40	33	34
11	43	34	33
12	43	35	33
13	45	36	32
14	48	37	32

15	49	38	31
16	50	39	31
17	52	40	30
18	52	41	30
19	54	42	29
20	54	43	29
21	54	44	28
22	53	45	28
23	52		

Some Physicochemical Properties of Leaf Compost (Organic Fertilizer)

Organic fertilizers are generally specified by their pH, moisture content, organic carbon content, electrical conductivity (EC) and C/N ratio. Therefore, chemical analyses were carried out by standard methods so as to know their specifications. The results are reported in Table 5. pH value of organic fertilizer was above 7 and it was slightly alkaline. The moisture content of sample was found to be 9.538%. The electrical conductivity value was 2.75 dSm^{-1}. This value is within the optimum range of (2.0 to 4.0) for growing media (Hanlon, 2012). Total organic carbon content was found to be 13.589% higher than the reported value 10% (Batjes, 1996). Regarding the value of total organic matter was 24.109% and C/N ratio was found to be 17:1. This result is in agreement with the results ranging from 15:1 to 20:1 and it is ideal for ready-to-use compost (Rosen *et al*., 1993).

Table 5. Some Physicochemical Properties of Leaf Compost (Organic Fertilizer)

Parameter	**Content**
pH	7.63
Moisture (%)	9.538
EC ($dS\ m^{-1}$)	2.750
Organic matter (%)	24.109
Organic carbon (%)	13.589
C : N	16.647

Analysis of Leaf Compost (Organic Fertilizer) by EDXRF

The relative abundance of some elements in organic fertilizer was determined by EDXRF technique. The EDXRF spectrum is shown in Figure 3. According to these data as shown in Table 6, it was found that the organic fertilizer contained the high amount of Si, Ca, Fe, K and many trace elements which are essential for plant growth were present in it.

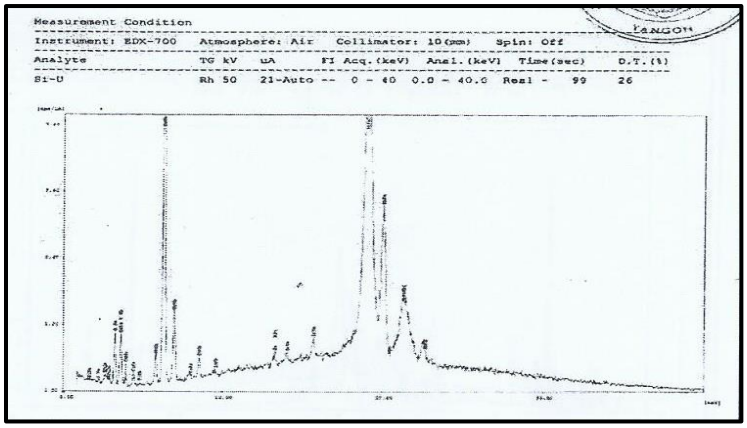

Figure 3. EDXRF spectrum of Leaf Compost

Table 6. Elemental Analysis of Leaf Compost (Organic Fertilizer) by EDXRF

Elements	Relative abundance (%)
Si	32.213
K	13.251
Ca	20.117
Fe	20.188
Al	7.345
Ti	1.860
S	1.912
Mn	0.772
P	0.138
Zn	0.083
Sr	0.321
Cr	0.144
Rb	0.117
Zr	0.171
Cu	0.045
V	0.066

Macronutrient and Micronutrient Contents in Leaf Compost (Organic Fertilizer)

The contents of macronutrients and micronutrients in prepared organic fertilizer were also determined. The values of total nitrogen, total P_2O5 and total K_2O were found to be 0.875%, 0.423% and 1.301% respectively. The results also indicated that the secondary nutrients (Ca, Mg and S) and the trace elements (Fe, Zn, Mn and Cu) which are necessary for

plants were found in the prepared compost (organic fertilizer). The data are presented in Table 7 and Table 8.

Table 7. Macronutrient Contents in Leaf Compost (Organic Fertilizer)

Macronutrients	Content
Total N (%)	0.875
Total P_2O_5 (%)	0.423
Total K_2O (%)	1.301
Ca (ppm)	152.400
Mg (ppm)	9.321
S (ppm)	0.072

Table 8. Micronutrient Contents in Leaf Compost (Organic Fertilizer)

Micronutrients	Content
Fe (%)	2.125
Zn (ppm)	1.340
Mn (ppm)	10.303
Cu (ppm)	0.187

CONCLUSION

In this research, the selected organic waste materials (cow dung and dry leaves) were recycled into useful compost (organic fertilizer). The waste materials were characterized by EDXRF, AAS and other modern and conventional methods. The results indicated that selected waste materials were suitable to use for the preparation of compost (organic fertilizer) due to the presence of macronutrients and micronutrients for the plants and soil. The prepared compost was also analyzed. The data analysis showed that prepared compost (organic fertilizer) was slightly alkaline and moisture content was 9.538%. The value of electrical conductivity (2.7 dSm^{-1}) was within the optimum range (2.0 to 4.0 dSm^{-1}). Total organic carbon (13.589%) was higher than the reported value (10%). The value C/N ratio was 17:1 and this value was ideal for ready-to-use compost. The compost (organic fertilizer) consists of the primary nutrients (0.875% N, 0.423%P_2O_5 and 1.301%K_2O) and the secondary nutrients (152.4 ppm Ca, 9.321 ppm Mg and 0.072 ppm S). It also contained other trace elements (Zn, Cu, Mn, Fe) needed in a small amount for plants. It was observed that the compost can be easily prepared and it can supply macronutrients and micronutrients in the appropriate proportion which is indispensable for plant growth. Therefore, it can be used as a fertilizer for farming and various kinds of crops in agriculture. With regard to this research, it can be suggested that the use of compost (organic fertilizer) made from wastes will not only supplement the chemical fertilizer but also reduce environmental pollution by disposal of waste to the land.

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