An Investigation on the Chemical Constituents in Prepared Fertilizers using Decayed Leaves of *Senna siamea* Lam.

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Abstract

Myanmar is an agricultural based country. So, the people working on agriculture should use organic fertilizers instead of chemical fertilizer. Using organic fertilizer can reduce the danger of the lives of consumers and can give the consumers the benefit of health. Therefore, in this research work, plant sample, *Senna siamea* Lam. was selected for preparing the organic fertilizers. To prepare the organic fertilizer, decay leaves of *Senna siamea* Lam., cow manure and soil were used. These samples were collected from Amarapura Township, Mandalay Region. They were mixed with the ratio of 4:2:1 weight by weight. The organic fertilizer samples were prepared by using anaerobic and aerobic methods. The yield percent, physical properties, nutritional values (N,P,K), organic carbon and organic matter of the prepared organic fertilizers were also determined by applying AOAC method. Moreover, mineral compositions in these fertilizer samples were analyzed by using EDXRF (Energy Dispersive X–Ray Fluorescence) spectroscopy.

Key words: Decay leaves of *Senna siamea* Lam., cow manure, soil, NPK, EDXRF

Introduction

In our country, about 70% of population of Myanmar is rural people who make a living by farming. So, Myanmar is an agricultural country. To optimum crop production, farmers buy and use chemical fertilizers, pesticides and fungicides which are being imported very expensive amount from foreign countries. These expensive agricultural materials have side effects on both human and soil health. Fertilizer is one of the sources for plant growth. It can be added to the soil as a supplement to natural fertility. There is usually a very dramatic improvement in both quantity and quality of plant growth when appropriate fertilizers are added. Proper use of fertilizer leads to the production of more nutritious food. Fertilizer is classified into chemical and organic fertilizers. Nowadays, most of the farmers all over the world are using organic fertilizer instead of chemical fertilizers and materials.

Organic fertilizers can give several benefits such as enhanced soil fertility and soil health which can lead to increased agricultural productivity, improved soil biodiversity, reduced ecological risks and a healthier environment. In Myanmar, organic farming systems are widely used more recently. Therefore, organic fertilizers which are being made by mixing green wastes or kitchen wastes or decayed leaves, animal dung and soil are being produced. Organic fertilizers are divided into two parts, aerobic and

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anaerobic fertilizers. Vegetables and leaves contain naturally rich nutrients. Animal dung contains organic microbial and mineral nutrients. Soil contains the bacteria which work to break down the organic matter. The composting process and bacteria make the nutrients soluble, which means that the plants can more readily absorb them from the soil (Website –1).

Aerobic digestion means the digestion process occurring in presence of oxygen and produces mixtures of gases having carbon dioxide CO_2. Carbon dioxide gas is one of the main green–house gases which are responsible for global warming. Anaerobic digestion is a series of biological processes that use a diverse population of bacteria to break down organic materials into biogas and a combination of solid and liquid effluents. It occurs in the absence of free oxygen (Website –2).

Therefore, this research stands for preparing the organic fertilizer which includes decay leaves of *Senna siamea* Lam. (Mezali), cow dung manure and soil which are being mixed with their respective ratio under aerobic and anaerobic conditions.

The aim of the present investigation is to study whether the rotten leaves of Mezali can be used as fertilizer or not. The objectives are to collect the decayed leaves of Mezali, cow manure and soil, to prepare the fertilizer by using anaerobic and aerobic methods, to analyze the elemental compositions in prepared fertilizers and to determine the chemical constituents of prepared fertilizers.

Botanical Description of Mezali

Family name	:	Caesalpiniaceae
Scientific name	:	*Senna siamea* Lam.
Local name	:	Mezali
Part used	:	Decay leaves
Medicinal Uses	:	skin diseases, purgative, laxative and infections and all poisonous insect bites
Other Uses	:	ornamental plants and landscaping The leaves and flowers → curries (edible)

"The buds of Mezali are eaten in Myanmar as traditional food at Full moon day of Tazaungmone (Tazaungtaing night)."

Figure 1. Mezali Leaves, Flower and Fruit

Materials and Methods

Sampling and Preparation

Decay leaves of Mezali, dried cow manure and soil were collected from Amarapura Township, Mandalay Region. They were mixed with the ratio of 4:2:1 weight by weight. To prepare fertilizer, 4kg of decay leaves of Mezali, 2kg of dried cow manure and 1kg of soil were weighed and put layer by layer successively. Prepared fertilizers were divided into two portions. First portion was placed under the ground about two feet depth and covered with the soil to prevent the air (anaerobic). The other was placed in the ground about two feet depth and uncovered with the soil to ventilate the air (aerobic).

Figure 2. Sample 1 (F 1, anaerobic)

Figure 3. Sample 2 (F 2, aerobic)

Determination of Moisture Content

Accurate weights of porcelain basins were first determined. Then about 2 g each of these samples were placed in basin separately and weighed accurately. They were allowed to dry in electric oven at 105°C, followed by being cooled in desiccator to get constant weight. (AOAC, 1995)

Determination of pH

pH values of prepared fertilizers were determined by pH meter.

Determination of Organic Carbon in prepared fertilizers

About 0.2 g sample was weighed in a conical flask. Exactly 10 mL of 1 M $K_2Cr_2O_7$ and 20 mL conc. H_2SO_4 were added. The solution was thoroughly mixed and allowed reaction to proceed for 30 minutes. The reaction mixture was diluted with 200 mL of distilled water and 10 mL of H_3PO_4 and 5 drop of diphenylamine. The solution was titrated with 0.5M $FeSO_4$ to a brilliant green color. A blank without sample was done simultaneously.

Calculation

$$\text{Organic carbon (\%)} = \frac{10}{\text{Blank}} \ (\text{Blank} - \text{Reading}) \times \frac{0.003 \times 100}{\text{Wt. of sample}}$$

Determination of Organic Matter in Prepared Fertilizers

About 0.2 g sample was weighed in 500 mL conical flask. Exactly 10 mL of 1 M $K_2Cr_2O_7$ was added by pipette and mixed by swirling the flask. Then 20 mL of conc: H_2SO_4 was added and mixed for one minute by gentle rotation. It was allowed to stand for 20 to 30 minutes. The reaction mixture was diluted with 200 mL of distilled water and 10 mL of H_3PO_4. Then it was cooled at room temperature. Diphenylamine indicator 5 drop was added and titrated immediately with 0.5 M ferrous ammonium sulphate

solution until end point was reached. Normal color changes were green to blue to blackish pink.

Calculation

$$\text{Organic matter (\%)} = 10\left(1-\frac{T}{S}\right)\times 0.672$$

S = standardization blank titration, T = sample titration

Determination of Nitrogen Content

About 0.5 g of sample was weighed and it was transferred to the digestion tube. Concentrated sulphuric acid (10 mL) and 5 g of catalyst mixture were added to the sample. The digestion tube was loaded into the Kjeldhal digester and heated the digestion unit and set the initial temperature 100°C till frothing is over. Then, block temperature was raised to 400°C. The effective digestion was done only at 360°C and beyond 410°C. The sample turned light green color or colorless at the end of the digestion process.

After the digestion tube was cooled, the tube was loaded in distillation unit and other side of hose keep 20 mL of 4 % boric acid with mixed indicator in 250 mL conical flask. 40 mL NaOH (40 %) is automatically added by distillation unit programme. The digested sample was heated by passing steam at a steady rate and the liberated ammonia absorbed in 20 mL of 4 % boric acid containing mixed indicator solution kept in a 250 mL conical flask. With the absorption of ammonia, the pinkish color turns to green. Nearly 150 mL of distillate was collected in about 8 minutes. Simultaneously, blank sample has to be run.

The green colored distillate was titrated with 0.1 N sulphuric acid and the color changes to original shade (pinkish color). Note the blank and sample titer reading (mL) and calculate the total nitrogen content present in sample.

Calculation

$$\text{Nitrogen content in sample (\%)} = \frac{\text{R(sample titer - blank)}\times\text{Normality of acid}\times\text{Atomic weight of nitrogen}\times 100}{\text{Sample weight (g)}\times 1000}$$

$$= \frac{R\times 0.1\times 14\times 100}{0.5\times 1000}$$

$$\text{Factor} = R\times 0.28$$

Determination of Available Phosphorus

About 2 g of sample was weighed accurately and placed into shaking bottle. Ammonium sulphate 400 mL and sulphuric acid buffer solution (pH = 3) was added and the bottle was shaken for half an hour. After that, it was filtered, 50 mL of filtrate was pipetted into 100 mL volumetric flask. Then 4 mL of 2.5 % ammonium molybdate solution was added. This was followed by the addition of 6 drops of freshly prepared chlorostannous acid and made up to the mark with distilled water. Within 15 minutes after adding the chlorostannous acid to the filtrate, the intensity of color was measured at wavelength 660 nm by using UV–VIS spectrophotometer.

Determination of Available Potassium

Available potassium content of the prepared organic fertilizers and commercial organic fertilizers were determined at Ministry of Agriculture and Irrigation, Department of Agriculture (Land Use), Mandalay, by using Atomic Absorption Spectroscopic Method.

Results and Discussion

Determination of Elemental Contents of Some Selected Materials

The elemental contents of some selected materials (Mezali leaves and soil) were determined by EDXRF spectrometer. The results are shown in Table 1.

Table 1. The Results of Elemental Contents of Some Selected Materials

No.	Symbols	Elements	Concentration (%)	
			Mezali	Soil
1.	Ca	Calcium	2.020	5.515
2.	Si	Silicon	1.324	1.693
3.	K	Potassium	1.069	1.590
4.	S	Sulphur	0.259	0.052
5.	Al	Aluminum	0.128	4.235
6.	P	Phosphorus	0.073	0.211
7.	Fe	Iron	0.010	1.989
8.	Sr	Strontium	0.008	0.022
9.	Mn	Manganese	0.003	0.053
10.	Zn	Zinc	0.002	0.039
11.	Br	Bromine	0.002	0.0004

From the experimental research, the percentage of calcium is the highest in both selected materials and aluminum is the second highest amount in soil sample. Moreover, silicon, potassium, sulphur, phosphorous, iron, strontium, manganese, zinc and bromine were also found in that order.

Determination of pH, Moisture, Organic Carbon and Organic Matter of Prepared Fertilizers by AOAC method

The pH value, moisture content, organic carbon and organic matter were determined. The results are described in Table 2.

Table 2. The Results of pH, Moisture, Organic Carbon and Organic Matter of Prepared Fertilizers

No.	Components	F1	F2
1	pH	8.5	8.5
2	Moisture Content (%)	2.80	2.13
3	Organic carbon (%)	6.00	3.52
4	Organic matter (%)	12.25	8.32

From these results, it can be seen that the yield percent of anaerobic condition was higher than aerobic condition. From pH value, two samples were alkaline condition. Moreover, prepared fertilizer 1 was more moistened than that of fertilizer 2. According to these results, fertilizer 1 was the larger percentage of all components than fertilizer 2. So, fertilizer 1 was more fertilizer quality than fertilizer 2. Because of the organic matter present in prepared fertilizers, soil structure improved and as a result, the soil's ability to hold onto water and nutrients increased (Russell, 1963).

Determination of Available Nitrogen, Available Phosphorus and Available Potassium in prepared fertilizers

Available nitrogen, phosphorus and potassium content of prepared fertilizers were determined. The results are presented in Table 3.

Table 3. The Results of Available Nitrogen, Available Phosphorus and Available Potassium in prepared fertilizers

No.	Components	%		Classification	
		F 1	F 2	F 1	F 2
1	Available nitrogen	0.0120	0.0087	High	Medium
2	Available phosphorus	0.0035	0.0032	High	High
3	Available potassium	0.0967	0.1072	Very high	Very high

Classification

	Very high	high	medium	low	very low
N	> 0.012%	0.009–0.012%	0.006–0.009%	0.003–0.006%	< 0.003
P	> 0.004%	0.003–0.004%	0.001–0.003%	0.0005–0.001%	< 0.0005
K	> 0.037%	0.025–0.037%	0.013–0.025%	0.0012–0.013%	< 0.0012

According to these data, the prepared fertilizers can supply micronutrient (trace elements) and macronutrients (N, P, K) to the plants. Plants need carbon dioxide, light and water for photosynthesis. But they also need nitrogen (N) for leaf growth, phosphorus (P) for development of roots, flowers, seeds, fruits and potassium (K) for strong stem growth, movement of water in plants, promotion of flowering and

fruiting(F.A.O 1982). Therefore, fertilizers were added to the soil to replace the elements used up by plants and to help crops growth (Russell, 1963).

Determination of Elemental Composition of Prepared Fertilizers

The elemental contents of prepared fertilizers were determined by EDXRF spectrometer. The results are shown in Table 4.

Table 4. The Results of Elemental Contents of prepared fertilizers

No.	Symbols	Elements	Concentration (%)	
			F 1	F 2
1	Si	Silicon	15.0300	12.6400
2	Ca	Calcium	3.7910	4.1390
3	Al	Aluminum	3.5430	2.1570
4	Fe	Iron	2.0950	1.3070
5	K	Potassium	1.5620	1.2130
6	Ti	Titanium	0.2627	0.1581
7	P	Phosphorus	0.2080	0.2432
8	Cl	Chlorine	0.1819	0.5889
9	S	Sulphur	0.0853	0.0931
10	Mn	Manganese	0.0454	0.0392
11	Sr	Strontium	0.0085	0.0019
12	Rb	Rubidium	0.0075	0.0061
13	Zn	Zinc	0.0071	0.0058
14	Br	Bromine	0.0007	0.0003

According to elemental analysis, Si, Ca, Al, Fe and K were found to be the highest values in both prepared fertilizers. Ti, P, Cl, S and Mn were found to be medium values of these fertilizers. Finally Sr, Rb, Zn and Br were found to be trace amount in the fertilizer samples. According to the elemental analysis, the amount of silicon, one of the fertilizer micronutrients was the highest value in two prepared fertilizers. Since the silicon generates the resistance in many plants to disease and pests, it may contribute to reduce the rate of application of pesticides and fungicides (F.A.O 1982).

Conclusion

In this research work, a number of minerals were found in the decayed leaves of Mezali and soil sample. To prepare the organic fertilizer, decaed leaves of Mezali, dried cow manure and soil were mixed by using anaerobic and aerobic methods. The

prepared fertilizer samples were analyzed to determine physical and chemical characteristics. According to Table 2, these samples were alkaline medium (pH 8.5). From the moisture value, fertilizer 1 (anaerobic) was more moistened than fertilizer 2 (aerobic). Fertilizer 1 was larger percent organic carbon and organic matter than fertilizer 2. Available nitrogen values of fertilizer 1 and fertilizer 2 were high and medium. Available phosphorus values are high in both samples. Available potassium values are very high in both fertilizer samples. According to the elemental analysis, silicon was the highest value in both samples (15.03 %, 12.64 %). The Second highest is the calcium (3.791%, 4.139 %). Third highest was aluminum. The remaining elemental components such as Fe, K, P and Ti were present in medium value.

According to above data, the rotten leaves of Mezali can be used as a fertilizer. Therefore, these prepared fertilizer samples may have some values on crops that demand an acidic soil. Organically produced foods and crops are hygienic for consumption and safer for the environment. Hence, there is a rapidly growing demand for organic fertilizers. In Mandalay and Yangon, organic fruits and vegetables are sold two days a week in organic market. Moreover, these prepared fertilizers may be suggested as an economic material. Instead of using chemical fertilizer, using organic fertilizer can reduce the danger of the lives of the consumers and can give the consumers the benefit of the health.

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References

AOAC. (1995). "Official Methods of Analysis of the Association of Official Analytical Chemists", Washington, DC., USA.

F.A.O., (1982), Soil/Bulletin 3 8/1 , “Soil and Plant Testing in Analysis, F.A.O, Rome, Italy

Russell, E. W ., (1963). “Soil Conditions and Plant Growth”, Norwich, England

Thida Aung Ma. (2014). "Preparation of Organic Fertilizer I ", Department of Chemistry, University of Mandalay.

Vogel, A. I. (1961). “Quantitative Inorganic Analysis”, 3rd Ed. Longman and Green Co. London, 256.

Online Materials

1.https://www.gardenguides.com/89749–benefits–chicken–manure.html

2.https://www.extension.uidaho.edu/publishing/pdf/CIS/CIS1215.pdf