Biotransformation of Rice Husk, Palm Oil Mill Effluent and Sewage Sludge through Bio composting

Nurjihan Binti Mohammad Nazar[a], Nurain Farahin Binti Abdul Razak[b], Mohd Zaki Bin Sukor [c].

[a,b,c,d] *Faculty of Chemical Engineering, UiTM Pasir Gudang*

Abstract

The present study investigated that rice husk make a potential fertilizers by bio-composting. Rice Husk was obtained from Kilang BERNAS, Paya Keladi, Pulau Pinang,while the POME were collected from Sime Darby Melaka, Malaysia and the sewage sludge were collected from Indah Water Konsortium,Johor Bahru. The organic waste were stored at temperature room,25°C in a storage.There are various experiments made using rice husk as main component to make a fertilizer by composting it with fruits bunch and worms. Besides that, other substance use to make a potential fertilizer is Palm Oil Mill Effluent (POME). POME contains several acidic nutrients needed to make a fertilizer. It is also used because of its high content of nitrogen. In addition, sewage sludge also use by various experiments to make a fertilizer. Sewage sludge contains high acidity which is good to make a better fertilizer. In this experiment, these three substances are used to make a fertilizer. Rice husk and the substituent mixed with ratio 1:9. The subtituents used in this were sewage sludge and POME with the ratio 70:30, 50:50 and 30:70 respectively. Besides , the mixture was stirred thoroughly in the containers. Then,the containers were place on a cover at an open field and were covered by a plastic bag. These containers were placed at the open field for 28 days to produce the result either in acidic or alkaline or both. After 28 days, there had a lot of changed in the mixture. The smelly became odourless, the colour became darkness, some of them were acidic and alkaline, the mixtures were composed roughly and it gave a different pH value for each of them. According to the result, Palm Oil Mill Effluents (POME) makes more acidic fertilizers than the Sewage sludge .Theoretically, the higher the acidic content in fertilizer the higher the quality of the fertilizers. Thus, higher POME content makes better fertilizers and it produced a healthy fertilizer for plant.

1. Introduction

Fertilizers are essential substances to add into soil or land to increase its fertility. There are two type of fertilizers which are chemical and biological fertilizers. Chemical fertilizers is raw chemical materials which being composed and manufactured at factory into liquid or solid forms that specifically target plants' nutritional needs. It is essentially designed to mimic naturally occurring nutrients. Chemical fertilizers were believed to provide immediate nourishment compared to its organic counterparts, which release nutrients much more slowly. However, the effectiveness of chemical fertilizers in long-term basis are being questioned by many experts. Chemicals fertilizers are very acidic, which in turn it's rising the acidity of the soil, thus it will reduce the beneficial organisms and stunting plant growth. The long-term use of these chemical fertilizers could eventually lead into a chemical imbalance in the recipient plants by upsetting this natural ecosystem. It is also can easily "burn" the plant and sometimes even kill them if it is overly used. In addition, when they accompany natural runoff from yard or garden, they also contribute to groundwater pollution and the process of manufacturing those releases greenhouse gases and other pollutants into the environment as well.

Biological fertilizer is an organic fertilizer which is derived from natural materials that have undergone minimal processing and generally applied in their original form. Generally , chemical and biological fertilizer work similarly accoring to their main function which is providing specific formulations of NPK (nitrogen, phosphorus and potassium) value in order to treat nutrient deficient soils and plants although they are differ origins. The type of fertilizers that we are using has a large impact on the quality of our product. There are several benefits of using organic fertilizer which are save environment, non-toxic food, fertility of soil, on farm production and low capital investment. Global awareness for the hazards of long-term chemical fertilizer use is growing. Because of this, more farmers all over the world are shifting to organic fertilizers due to the apparent benefits of the latter. The agricultural market has also recognized this trend, and has recently employed a full-blown campaign to promote organic and natural fertilizers to the world.

One of way to invent the biological fertilizers is by bio composting. Bio composting is the biological process of breaking up of organic waste such as food waste, manure, leaves, grass trimmings, paper, worms, and coffee grounds and more into an extremely useful humus-like substance by various micro-organisms including bacteria, fungi and actinomycetes in the presence of oxygen. There are several examples of fertilizers invented by bio composting. For example, fertilizers from the bio compost of the rice husk and banana, papaya and honey dew.

In Malaysia,most of malaysian cuisine are based on rice.About 600 million tons of rice paddies are produced and 20 % of them are made of husk every year (Chandra,2007). Rice husk were dried in open field before storage. The reuse of these ashes on agricultural land can help to improve physical and chemical fertility of soil (Petch et al.,2015).

Palm Oil Mill Effluent (POME) was produced by the oil extraction process from palm oil industry in a large quantity. In order to extract the crude palm oil (PO), the enourmous amounts of water are needed. Almost half from the water discharge in fresh fruit bunches is POME. POME is the combination of waste that produce and discharge from three principle source which 60% of clarification of waste water, 36% sterilizer condensate and 4 % hydrocyclone waste water. Raw POME are thick brownish,viscous and voluminous colloidal matters. It contain 95-96% of water, 4-5% of total solids including 2 -4% suspended solids and 0.6-0.7% oil and grease which is discharge at temperature 80-90°C (Yunus et al.,2015). Raw POME is also acidic which contain with an intense amount of amino acids, inorganic nutrients (Na, K, Ca, Mg, Mn, Fe, Zn , Cu, Co and Cd) and short fibres are content in POME (Borja,1994). Malaysia is the second largest country to produce POME after Indonesia in the last decade. In 2014, Malaysia have produced palm oil about 62.34 million tonners. It is measured almost 0.5-0.75 % of POME was produce in one tonne of fresh fruit bunch (Yacob et al., 2006). POME's plentiful organic matters could become a hopeful source renewable energy.

In 9th December 1993, the national sewerage privatization was handed to Indah Water Konsortium Sdn.Bhd. by Goverment of Malaysia to manage a more modern and efficient sewerage system for the country (Rosenani et al., 2004). Malaysia has produce about 5 million m^3 sewage sludge every year. Sewage sludge were apply to agriculture land as the most economic outlet for sludge because there is an opportunity to recycle beneficial plant nutrienrs and organic matter in soils used for crop production. The nitrogen and phosphorus fertilizer replacement value of sewage sludge has been reported frequently as the example (Kelling *et al.,* 1977; Sommers *et al.,* 1980; Coker *et al.,* 1987). Organic matter in sewage sludge can also increase crop productivity by improving soil physical and chemical properties (Pagliai et al., 1981; Smith et al., 1992).

2. **Methodology**

2.1 Collection of organic waste

The organic wastes used in this study were rice husk, palm oil mill effluent (POME), and sewage sludge. Rice husk was obtained from Kilang BERNAS, Paya Keladi, Pulau Pinang, while the POME were collected from Syarikat Kilang Sawit Muar Bhd and the sewage sludge were collected from Indah Water Konsortium, Johor Bahru. The organic waste were stored at temperature room,25°C in a storage.

2.2 Experimental Set Up

According to Muhrizal et al.,(2006), the ratio of POME : PALM OIL FIBRE was 1:9 by mass. Thus, in this experiment ,the ratio of substituents:RH was 1:9. The subtituents used in this experiment were POME and sewage sludge with ratio 90:10, 70:30, 50:50, 30:70 and 10:90 respectively. The mixture was stirred thoroughly in the containers. Then, the containers were place on a cover at an open field and were covered by a plastic bag. These containers were placed at the open field for 28 days.

2.3 pH Reading

The initial reading of rice husk,POME,sewage sludge and the mixture of 50:50 ratio of subtituent are taken. Besides that, all the ph final reading of all mixtures are also taken after 28 days.

3. Result and discussion

In this present study, pH of all the final bio compost showed alkaline and acid conditions after 21 days of bio composting. POME and sewage sludge are the main substances in the mixture to produce the result whether in acidic or alkaline. The result were recorded their pH value to prove it by using a pH meter. The initial pH value for rice husk, sewage sludge and Palm Oil Mill Effluent (POME) are 7.6, 6.5 and 4.6 respectively. The mixture showed the ratio had same produced where five alkaline and five acidic. Even though both of them are acidic, but they produced different pH result. The pH values are 7.5, 8.0, 8.3, 8.5, 6.1, 6.2, 6.4 and 6.8 respectively. In general, the pH value for neutral is 7.0 and the below of it is acidic while the upper of it is alkaline. According to the result, the highest value of pH is 6.1 which it shows that the pH of ratio70:30 (sewage sludge: POME) is the most acidic. Therefore, the final pH value of bio composting obtained from mixture showed the highest content of acidic is Palm Oil Mill Effluent (POME) compared to sewage sludge.

According to Ahmad et al. (2006), the more it's acidic, the more it will provide a healthy fertilizer and good for the fertility of the plant compared to alkaline. The fertilizer which contain more alkaline, is not appropriate to label as a good fertilizer and it cannot provide a good fertility to plant (Ahmad et al., 2006). Furthermore, the rice husks become more compost after it was mix with the sewage sludge and POME after 28 days. The mixtures also changed color which they became brown-black color. The color will show the mixtures ware highly composed or not (Lim et al., 2012). The darker color, the more it compost and became a good fertilizer to fertile the plant. In addition, the mixtures also changed from smelly into odorless. Based on observation, the odor became odorless because of the radiation of the sunlight when the mixtures were put under the sunlight (not directly) for 28 days.

Table 1 The initial pH Rice Husk, Sewage Sludge and POME

Substance	pH Initial
Rice Husk	7.6
POME	4.6
Sewage Sludge	6.5
Mixture (50:50 ratio of SS:POME)	6.9

Table 2 The pH final of mixture of the Rice Husk, Sewage Sludge and POME according to the substituent's' ratio.

Ratio of Substituent (POME:SS)	pH Final	
	1	2
30:70	8.3	8.5
50:50	7.5	8.0
70:30	6.1	6.2

In a nut shell, the fertilizer from organic substances like mixture of rice husk, POME and sewage sludge will provide a good fertilizer and it also had no content of chemical substances. Besides, it is low cost and renewable energy so anyone can have it and the source can provide easily. In future, the rice husk is suggested to be blended before being mixture and to get a better a result. The mixtures of rice husk, POME and sewage sludge also recommended to be placed in open field in longer time so it can be more composed.

4. Conclusion

The present experiment shows that bio-composting of rice husk, POME and sewage sludge with the right ratio can be used to make a potential biological fertilizer. According to the result, Palm Oil Mill Effluents (POME) makes more acidic fertilizers than the Sewage sludge. Theoretically, the higher the acidic content in fertilizer the higher the quality of the fertilizers. Thus, higher POME content makes better fertilizers and it produced a healthy fertilizer for plant. Besides, the mixtures were composed roughly together, the colours were turned dark and smelly smell turned to odourless. The change showed that the mixture in a healthy fertilizer and it will produce a best fertile to plant growth. The more it composed, the smoother decay will be produced. This clearly showed these mixtures were good to use as fertilizers in future.

Acknowledgements

A deepest appreciation to Kilang BERNAS, Paya Keladi, and Pulau Pinang for providing us the rice husk, Syarikat Kilang Sawit Muar Bhd for providing the POME, Indah Water Konsortium, Johor Bahru for providing the sewage sludge smples and all those who provided us the possibility to complete this report.

References

Ahmed, Y., Yaakob, Z., Akhtar, P., & Sopian, K. (2015). Production of biogas and performance evaluation of existing treatment processes in palm oil mill ef fl uent (POME). *Renewable and Sustainable Energy Reviews*, *42*, 1260–1278. http://doi.org/10.1016/j.rser.2014.10.073

Azizi, a. B., Lim, M. P. M., Noor, Z. M., & Abdullah, N. (2013). Vermiremoval of heavy metal in sewage sludge by utilising Lumbricus rubellus. *Ecotoxicology and Environmental Safety*, *90*, 13–20. http://doi.org/10.1016/j.ecoenv.2012.12.006

Benassi, L., Bosio, a., Dalipi, R., Borgese, L., Rodella, N., Pasquali, M., … Bontempi, E. (2015). Comparison between rice husk ash grown in different regions for stabilizing fly ash from a solid waste incinerator. *Journal of Environmental Management*, *159*, 128–134. http://doi.org/10.1016/j.jenvman.2015.05.015

Essabir, H., Achaby, M. E., Hilali, E. M., Bouhfid, R., & Qaiss, A. (2015). Morphological, Structural, Thermal and Tensile Properties of High Density Polyethylene Composites Reinforced with Treated Argan Nut Shell Particles. *Journal of Bionic Engineering*, *12*(1), 129–141. http://doi.org/10.1016/S1672-6529(14)60107-4

Hossain Molla, A., Fakhru'L-Razi, A., & Zahangir Alam, M. (2004). Evaluation of solid-state bioconversion of domestic wastewater sludge as a promising environmental-friendly disposal technique. *Water Research*, *38*(19), 4143–4152. http://doi.org/10.1016/j.watres.2004.08.002

Jearanaisilawong, P., Eahkanong, S., Phungsara, B., & Manonukul, A. (2015). Determination of in-plane elastic properties of rice husk composite. *Materials & Design*, *76*, 55–63. http://doi.org/10.1016/j.matdes.2015.03.042

Lim, S. L., Wu, T. Y., Sim, E. Y. S., Lim, P. N., & Clarke, C. (2012). Biotransformation of rice husk into organic fertilizer through vermicomposting. *Ecological Engineering*, *41*, 60–64. http://doi.org/10.1016/j.ecoleng.2012.01.011

More, T. T., Yan, S., Tyagi, R. D., & Surampalli, R. Y. (2010). Potential use of filamentous fungi for wastewater sludge treatment. *Bioresource Technology*, *101*(20), 7691–7700. http://doi.org/10.1016/j.biortech.2010.05.033

Teh, C. Y., Wu, T. Y., & Juan, J. C. (2014). Potential use of rice starch in coagulation–flocculation process of agro-industrial wastewater: Treatment performance and flocs characterization. *Ecological Engineering*, *71*, 509 519. http://doi.org/10.1016/j.ecoleng.2014.07.005

Thind, H. S., Yadvinder-Singh, Bijay-Singh, Varinderpal-Singh, Sharma, S., Vashistha, M., & Singh, G. (2012). Land application of rice husk ash, bagasse ash and coal fly ash: Effects on crop productivity and nutrient uptake in rice-wheat system on an alkaline loamy sand. *Field Crops Research*, *135*, 137–144. http://doi.org/10.1016/j.fcr.2012.07.012

Ting, S. S., Zulkepli, N. N., & Ismail, H. (2014). Tensile Properties and Water Absorption of Spear Grass Fibre Filled High Density Polyethylene / Thermoplastic Soya Spent Powder Composites, *10*, 49–57.

Yadav, D., Kapur, M., Kumar, P., & Mondal, M. K. (2015). Adsorptive removal of phosphate from aqueous solution using rice husk and fruit juice residue. *Process Safety and Environmental Protection*, *94*(August), 402–409. http://doi.org/10.1016/j.psep.2014.09.005

Zaini, M. A. A., Zakaria, M., Mohd.-Setapar, S. H., & Che-Yunus, M. a. (2013). Sludge-adsorbents from palm oil mill effluent for methylene blue removal. *Journal of Environmental Chemical Engineering*, *1*(4), 1091–1098. http://doi.org/10.1016/j.jece.2013.08.026