Chemical Properties of Vermichar Tea derived from Agricultural Waste and its potential as an alternative fertilizer in farming practice

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Abstract

Vermichar is a unique blend of dry leaves and charcoal using earthworm composting technology. A study was conducted to examine the Vermichar Tea's chemical properties and its potential as an alternative fertilizer in farming practice. African night Crawler worm (*Eudrilus eugeniae*) was used for the vermicomposting process. The worms were feed on dried leaves, banana tree stems and goat dung and left undisturbed for 30-90 days. Vermicompost was harvested for the interval of 30, 60 and 90 days and mix with charcoal, EM and molasses to prepare vermichar and was send to lab for nutrient analysis. The study revealed that the vermichar tea prepared from 90 day compost have Total Carbon level of 25.6%, 2.8% of Nitrogen level, 2.17% of Phosphorus level, pH value of 7.8 and C:N ratio at 10.67 which is within the characteristics of a good compost and have high potential to become alternative fertilizer in farming practice. All of the characteristics are within the range of good compost level. Hence, Vermichar Tea have high potential to be developed as an alternative source of nutrient in farming practice.

Keywords: Vermichar Tea Fertilizers, Earthworm

1. Introduction

Chemical fertilizers are applied to crops to enhance their performances. Before the 1950s, most farming practices are done on small or family scale with limited use of chemicals. The shift since then to larger corporate farms has coincided with the use of chemical fertilizers in modern agricultural practices (United States Environmental Protection Agency, 2018). Based on reports by USDA ERS in 2014 proved that the total nitrogen chemical fertilizer usage has steeply increase from 17.0 lbs/acre/yr in 1960 to 82.5 lbs/acre/yr in 2007. The drastic increase in fertilizer application has contributed significantly in increasing agricultural productivity and reducing hunger worldwide (Smil, 2002). Yet, the excess use of fertilizers is proven to cause a number of environmental and ecological problems, such as air pollution, soil acidification and degradation, water eutrophication, crop yield reduction, and undermining of the sustainability of food and energy production from agricultural fields (Lu & Tan, 2012).

Moreover, Phosphorus and nitrate-based fertilizers, are produced using oil and gas which are actually energy-intensive approaches. In addition, phosphate-based fertilizer relies on the mining of phosphate, a finite and unsustainable resource, and a production process using various toxic chemicals (Hofmeyr, 2015). Effects of chemical fertilizers application is not instantly seen on soil because soils have strong buffering power due to their components. Over the time, it emerged from the pollution, reduce the soil fertility and soil degradation responses in the soil leads to decline in the stability of the soil (Savci, 2012). Moreover, chemical fertilizers are also can cost soil compaction which will slow plant growth, thin stand, uneven early growth, and abnormal rooting patterns (Mari, Changyinh, & Jun, 2008).

Furthermore, the use of chemical fertilizer can give destruction of soil biodiversity. Fertilizer application begins the destruction of soil biodiversity by diminishing the role of nitrogen-fixing bacteria and amplifying the role of everything that feeds on nitrogen. These feeders then speed up the decomposition of organic matter and humus. As organic matter decreases, the physical structure of soil changes. With less pore space and less of their sponge-like qualities, soils are less efficient at storing water and air (Savci, 2012).

Worm compost is one of the highest grades and most nutrient rich natural fertilisers in the world. Its soil conditioning properties and plant strengthening effect encourage the growth and yield of the plants. Similar to the soil found in forests, vermicompost is black, odourless and crumbly substrate which has balanced nutritional composition for plants and it contains an above average number of microorganisms which revitalise the soil. Vermicomposting is also a low-cost technology system used for conversion of organic waste into organic fertilizers (Aracon et al., 2004) where numerous interactions between worms and microorganisms happen in the worm gut (Edwards & Arancon, 1998). Earthworms can consume practically all kinds of organic matter typically that placed in a compost pile, and they can eat wastes typically equal to their own body's weight per day.

Meanwhile, biochar refers to materials that are rich in carbon produced from slow pyrolysis (heating in the absence of oxygen) of biomass. Recently, studies suggested that biochar can works as a soil amendment to improve and maintain soil fertility and improve soil carbon sequestration (Lehmann & Joseph, 2009). Yet, some agronomist argued that biochar of plant material is often low in nutrients, especially nitrogen, as compared with other organic fertilizers (Chanetal, 2007). Therefore, we need to add other nutrient sources to biochar before we apply it as fertilizer.

Hence the study was conducted to produce cheap organic foliar fertilizers by reusing own agriculture waste by composting method. The parameters studied were total carbon, Total Nitrogen, Total Phosporus, C/N ratio and pH.

2. Materials & methods

2.1 Composting process

This study was conducted experimentally. First, a transparent container was prepared for producing vermicompost by the size of 0.0675 m^3. Numerous rows of holes approximately by the diameter of 1cm for aeration and drainage of excess moisture was placed in the side of the tank. Then, a layer of dried leaves, banana tree stems and goat dung were transferred to the container. Make sure the unacceptable materials for worms should be separated (meat, dairy products, fish, been etc.). After that 250g of African Night Crawler (*Eudrilus eugeniae)* were transferred to the tank and then a layer of the primary media of the worm with a little water (for humidity) was poured on the waste mixture and worms (Figure 1). Regular checking was done to the container to make sure the beddings were always wet and the temperature in the container were maintained by mixed the bedding once in a week. The sampling was done for the frequency interval of 30 days from the production container for nutrient analysis.

2.2 Vermichar tea preparation

Before analysing the samples, were separated and 1kg of the compost were mixed with 20L distilled water. Then, 1kg of well grinded charcoal were added into the solution and mixed well so that both the charcoal and vermicompost are well distributed in the solution; effective microbes (EM) and molasses were also added into the mixture as a source of nutrient for beneficial microbial development and actively aerated for 24 hrs. Finally, the prepared solution was sent to lab for nutrient analysis. The vermichar tea preparation process was done for every 30, 60 and 90 days of composting period.

All the samples were analysed using LaMotte colorimeter.

3. Results and discussion

The data were recorded for each of the samplings for 30, 60 and 90 days. All the data were equated to the Indonesian National Standard for compost (Table 1) where good quality compost should have total carbon value ranging between 9.8-32%, minimum Nitrogen value is 0.40%, C/N ratio is between 10-20%, minimum Phosphorus level is 0.10% and pH value between 6-9. The nutrient content of vermichar tea that prepared on 30-day compost have very high value of Total carbon that is 33.46%, and Nitrogen level at 2.1%, Phosporus at 1.43 C/N ratio at 17.6 and pH level at 7.3 (Table 1). Although, the nutrient values are within the range of good quality compost standard yet the high C:N ratio might restrict the availability of Nitrogen in the soil. Studied done by USDA Natural Resources Conservation Service, 2011 supported the statement above where the added organic material contains more nitrogen in proportion to the carbon, then nitrogen is released into the soil from the decomposing organic material. On the other hand, if the organic material has a less amount of nitrogen in relation to the carbon then the microorganisms will utilize the soil nitrogen for further decomposition and the soil nitrogen will be immobilized and will not be available.

Furthermore, nutrient content of vermichar tea that prepared on 60-day and 90-day compost have Total carbon (C) value within the standard and relatively the Nitrogen (N) and Phosphorus (P) level also increased. The carbon content in the compost reduce relatively because of the microbial activities while increase the nutrient level in the compost. These findings are similar to what Jakubus (2016) explain where a number of microbiological and chemical processes take place in the course of composting, which can result amongst other things, in a loss of organic matter, simultaneously causing a quantitative change in nutrient levels. Therefore, Phosporus is not lost by volatilization or lixiviation during the composting process, but Phosporus concentration might increase as composting proceeds (Warman & Termeer, 1996). Hence the C:N ratio was reduced accordingly till reach 10.67 level on vermicar tea that produce using the 90th day of vermicompost. Meanwhile, for all the 30, 60 and 90 days of composts shows not much change in the pH value where the value slightly change from 7.3 for 30 days vermicompost to 7.8 for 90 days vermicompost (Table 1).

The percentage (%) of Total Carbon (C), Nitrogen (N), Phosporus (P) and C/N ratio of vermichar Tea of 30, 60 and 90 days with trendline prediction for 120 days and 150 days shows that the Total Carbon in the vermicompost continuously reduce yet still within the standard compost level while the value of C:N ratio reduce drastically to 7.5 (Figure 2) which will limit the microbial population and slow down microbial activity in the compost due to relatively low amount of carbon. This was supported by findings of Jakubus (2016).

The percentage of Nitrogen and Phosphorus expected to shows a slight increasing trend after 120 and 150 days of compost respectively where the percentage of Nitrogen is 3.1 after 120 days and 3.5 after 150 days. While, the Phosphorus value expected increase to 2.21% and 2.61% respectively.

4. Conclusion

Therefore, the study revealed that the vermichar tea that was prepared from 90 day compost have all the desirable characteristics of a good compost and have high potential to become alternative fertilizer in farming. Appropriate planning, in order to manage the environment better and economically and also the implementation of the integrated Agriculture waste management's priority particularly reducing the farming waste by composting was the key findings of this study. Further studies to investigate the effect of vermichar tea on the vegitative growth of vegetables compared with commercial fertilizers. Vermichar tea also can be used as a source of nutrient in hydroponic system as it contain low level of C:N, high N and P level.

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Table 1: The percentage (%) of Total C, Nitrogen (N), Phosphorus (P), C/N ratio and pH values of vermichar Tea of 30 days, 60 days and 90 days compared to Indonesian National Standards for compost.

Parameters (%)	Indonesian National Standard for compost	30 days of compost	60 days of compost	90 days of compost
Total Carbon	9.8-32	33.46	28.53	25.6
Nitrogen	0.40 (MIN)	1.9	2.32	2.8
C/N ratio	10-20	17.6	12.30	10.67
Phosphorus	0.10	1.43	1.70	2.17
pH (value)	6-9	7.3	7.7	7.8

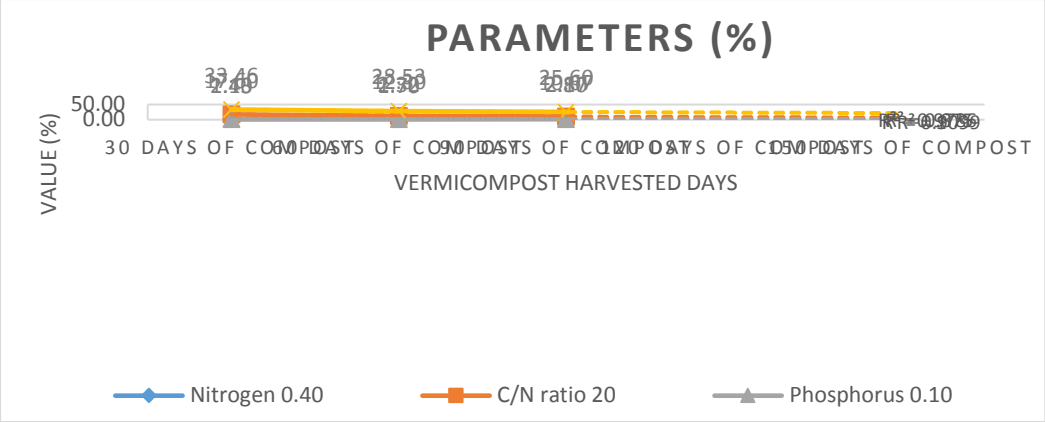

Figure 2: The percentage (%) of Total C, Nitrogen (N) Phosphorus (P) and C/N ratio of vermichar acid of 30 days, 60 days and 90 days with trendline prediction for 120 days and 150 days

Figure 1: The container which were prepared with agriculture waste as bedding for the earthworms and the vermichar tea