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The Analysis of Peat Soil Biological Characteristics after Being Incubated Using Vermicompost From a Mixture of Chicken Dung, Banana Hump, and Tofu Waste

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ABSTRACT

Peatlands are formed from piles of trapped plant residues, obstructing their decomposition process. The organic matter decomposition process certainly involves soil microbes. This study aims to determine the biological characteristics of peat soil after incubation with vermicompost. This research was conducted at Kampung Perlabian Village, Kampung Rakyat Sub-district, South Labuhanbatu Regency, North Sumatra. Soil biological analysis was conducted in the soil biology laboratory, Faculty of Agriculture, University of North Sumatra. This study used a non-factorial Randomized Block Design (RAK) with three treatments: P0 (control), P1 (1 kg peat soil + 500-gram vermicompost), and P2 (1 kg peat soil + 1 kg vermicompost). The results showed that adding vermicompost fertilizer to peat soil with treatment two could increase the total bacteria by 6.17 x 106 cfu/ml and the total fungus by 8.8 x 10^5cfu/ml, and CO_2 respiration by 4.125 (mg $CO/_{day}$). As a result, the soil's microorganism's activity is a process in which microorganisms live and do activities in a soil mass.

Keywords*: Soil Biology, Vermicompost, Peat Land, Organic Fertilizer*

1. INTRODUCTION

Indonesia has a peatland area of around 14.95 million/ha spread from the islands of Sumatra, Kalimantan, Papua and a small part in Sulawesi (Wahyu *et. al*., 2013). Peatlands can absorb and store water much higher than mineral soils. The water contained in peat soils can reach 300-3000% dry weight, much higher than in mineral soils, where water absorption capacity is only around 20-35% dry weight (Elon *et al*., 2011).

Peatlands are formed from piles of plant residues trapped and hampered by the decomposition process due to water saturation (anaerobic) (Gabov et al., 2020), so peatlands are still not optimal. The process of decomposition of the organic matter certainly involves soil microbes. The quality of peat soil is strongly influenced by the presence and role of soil organisms, both microorganisms, mesofauna, and macro soil fauna (Briones*,* 2014).

The microorganisms population is influenced by environmental factors such as soil acidity. The number of microorganisms tends to decrease with increasing soil acidity. Nitrogen-fixing, nitrite, and cellulose-degrading bacteria are rare in poor oligotrophic peatlands. However, in rich peatlands, with high pH values and classified as eutrophic peat, Azotobacter bacteria are often found (Noor*.,* 2020).

Vermicompost fertilizer is fertilizer taken from the media where the worms live. The media where the worms live are various, including organic waste, sawdust, livestock manure, straw, and others. Earthworms, known as a casting, or the composting process, can also involve macro-organisms. The collaboration between earthworms and microorganisms impacts the decomposition process that goes well (Sinha*,* 2020). Vermicompost contains nutrients that plants need, especially if the C/N value is less than 20; casting can be used as fertilizer (Simanungkalit *et al.,* 2006).

Vermicompost contains many nutrients and growth regulators that are beneficial for plants. According to Sathianarayanan dan Khan (2020), In vermicompost, there are growth-stimulating substances such as giberlin, cytokinin, ausin, and nutrients N, P, K, Mg, Ca, as well as Azotobacter sp bacteria which are non-symbolic N-fixing bacteria that will help enrich the N elements needed by plants. Vermicompost also contains various micro nutrients needed by plants such as Fe, Mn, Zn, Bo, and Mo (Munroe, 2020). on the benefits of vermicompost from the various literature above, it is expected that there will be an increase in the number of soil microorganisms if vermicompost fertilizer is added to peat soil. The vermicompost in this study will use chicken manure, banana weevil waste, and tofu dregs as feed and media for cultivating earthworms.

2. MATAERIAL AND METHOD

The research was carried out from December 2021 to February 2022 by analyzing the soil before and after being incubated with vermicompost. The tools and materials for this research are soil samples from oil palm stands, vermicompost fertilizer, polybags, water, watering can, and others.

Making vermicompost is done by keeping earthworms for four weeks.

Cultivation media was made from a mixture of 3 kg of soil, 1 kg of earthworm seeds of Lumbricus rubeltus species measuring 8 cm. Worms are fed every 2-3 days by giving 1 kg of chicken manure which has been diluted with water, 500 grams of banana weevil waste and 500 grams of tofu dregs. Earthworm treatment is done by stirring the media at the time of feeding. After four weeks, the vermicompost is harvested and packaged for further testing in the Soil Biology laboratory, Faculty of Agriculture, University of North Sumatra. The soil improvement test was performed by mixing peat soil and vermicompost fertilizer according to the treatment in 2 kg polybags. After mixing well, the mixture is added with peat water until it reaches field capacity. Each treatment was repeated three times and incubated for four weeks. The soil samples were then analyzed for their biological properties with the observation parameters: Total Bacteria Test, Total Fungus Test, and CO_2 Respiration.

This research was conducted with a non-factorial randomized block design with the following treatment levels:
PO = control (1 kg of peat soil)
P1 = 1 kg of peat soil + 500 grams of vermicompost
P2 = 1 kg of peat soil + 1 kg of vermicompost

3. RESULT AND DISCUSSION

a. **Total Bakteria** (cfu/ml)

Soil microorganisms are important factors in soil ecosystems because they affect the cycle and availability of plant nutrients and soil structure stability. The population of soil microorganisms is influenced by various conditions such as vegetation density, temperature, energy sources, and humidity (Rusdi et al., 2014). According to Wicaksono et al. (2015), in addition to mineral materials and organic materials, the regional climate conditions, growing vegetation, reactions that take place, and humidity levels affect the population of microorganisms in the soil.

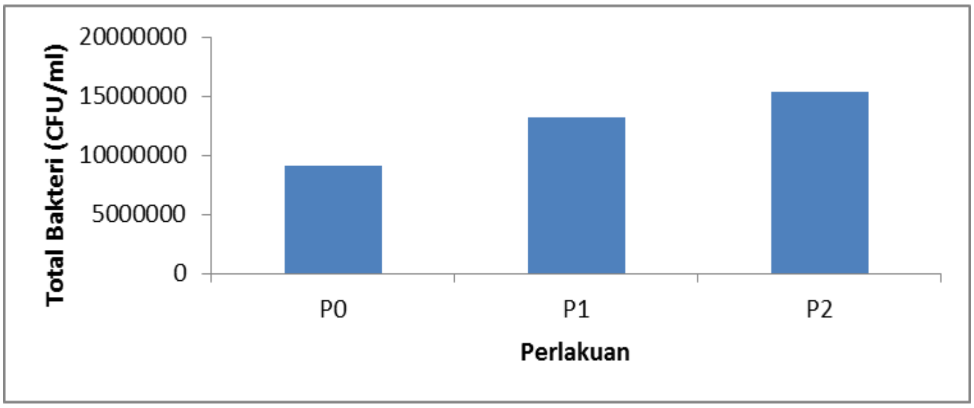

Figure 1. Bacteria Total Population Chart

Based on Figure 1, it is known that the addition of vermicompost fertilizer on peat soil can increase the population of soil bacteria. The average total bacteria found in the P2 treatment was 1.53 x 107cfu/ml with the addition of about 6.17 x 106cfu/ml from the control treatment, which was 9.13 x 106 cfu/ml. This outcome follows the literature by Rao (1994), which says that the more organic fertilizers are applied to the soil, the more soil microorganisms will develop. This is because the organic matter contained in organic fertilizers is used as a source of life.

Giving vermicompost on peat soil greatly influences the nutrients in peat soil because vermicompost is rich in soil microorganisms such as bacteria. Based on research by Yulipriyanto (2010), worm density will contribute to vermicompost on soil aggregates and organic matter, which can fertilize land in the rhizosphere area so that the value of the nutrient function and organic matter for plant growth becomes effective. Earthworm activity can remodel plant organic matter into minerals; some are stored as soil organic matter. Soil organic matter plays an important role in improving soil physical properties, increasing soil biological activity, and increasing nutrient availability for plants (Sembiring *et al.,* 2020)

Based on Pratiwi *et al.* (2018) stated that the peat soil at location A at a depth of 0-20 cm had a bacterial count of 2.10 x 108, namely: Azotobacter sp., Bacillus Lucifferents, B. Salarius, B. soli, Cupriavidus Paucalus, Mycobacterium Cubhense, Paenibacillus Illinoisensis, and P. Wynnii. While at a depth of 20-40 cm, there were 4.50 x 105 fewer bacterial species, e.g., Bacillus Kribbensis, Bacillus Panaciterrae, Chryseobacterium Balustinum, and Paenibacillus Peoriae. At location B, there were 2.21 x 108 bacteria at a depth of 0-20 cm and 1.60 x 106 bacteria at a depth of 20-40 cm, with fewer microbes found and dominated by six species of bacteria (Bacillus Salarius, B. soli, Cupriavidus). Paucalus, Nocardia Jiangxiensis, Paenibacillus Wynnii, and Pseudomonasaeruginosa), while at location C at a depth of 0-20 cm, there were 2.60 x 106 bacteria and 5.00 x 105 bacteria at a depth of 20-40 cm which was dominated by only five microbial species (Bacillus vallismortis, Nocardia jiangxiensi, Paenibacillus glycaniliticus, P. peoriae, and Rhodococcus equi)

B. Total Fungus

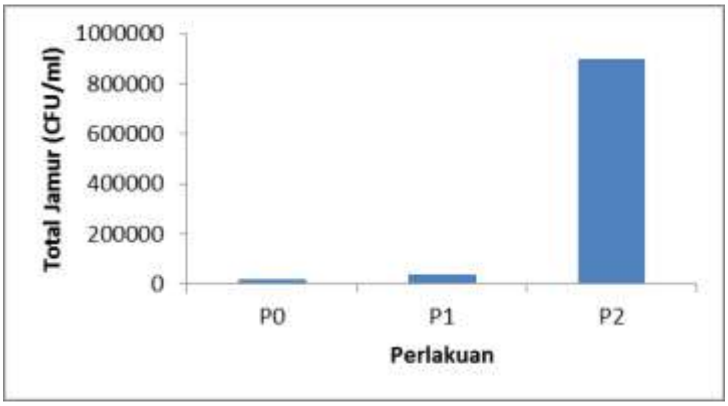

Figure 2. Fungus Total population

Likewise, with the total mushroom parameters, based on Figure 2, it is known that adding vermicompost fertilizer can increase the number of soil fungus populations. The average mushroom population was found in treatment P2 as much as 9 x 10^5 cfu/ml with the addition of about 8.8 x 10^5cfu/ml from the control treatment (P0) as much as 2 x 10^4 cfu/ml. Destia *et al.* (2021) state that adding organic matter to the soil will improve the life of microorganisms in the soil, such as fungi. Sinda *et al.* (2015) confirmed in their research that the dose of vermicompost fertilizer significantly affected the total population of soil microorganisms. The highest total population of microorganisms was found in the O8 treatment, which was 41.81x108 spk. The lowest total population of microorganisms was found in the control treatment, which was 3.01x108 spk.

Based on Pratiwi *et al.* (2018) research data, the number of fungal populations on peat soil in Tanjung Jabung Timur, Jambi Province, with locations (Peat under oil palm stands, deep drainage) at a depth of 0-20 cm as much as 5.00 x 105, peat under oil palm stands, shallow drainage at depths 0-20 cm and 20-40 cm are 2.67 x 105 and 2.50 x 105. Furthermore, (Logged peat forest with a depth of 0-20 cm and 20-40 cm is 1.11 x 107 and 3.50 x 105. While Yolanda's (2020) study respot stated that there were five isolates found in the roots of pineapple plants on peatlands: Penicillium sp., Aspergillus sp., Trichoderma sp., Penicillium sp., and Mucor sp. with an average mushroom population of 2.6 x 104 CFU/g Roots

C. Total Respiration CO_2

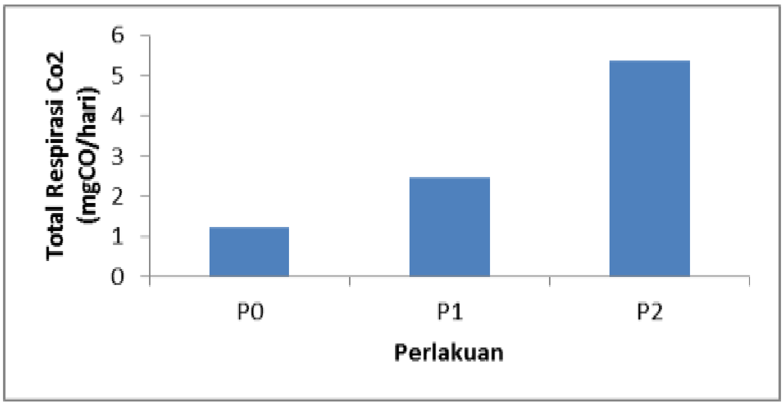

Figure 3. Total Respiration

According to Sembiring (2019), Observation of soil respiration is one indicator of soil biological activity such as microbes, plant roots, or other life in the soil, and this activity is very important for ecosystems in the soil. Determination of soil respiration is based on the amount of CO2 produced by soil microorganisms and the amount of O2 used by soil microorganisms.

Based on Figure 3, it is known that the addition of vermicompost on peat soil can increase the total CO2 respiration. The highest total respiration was found in the P2 treatment, which was 5.364 (mg $CO/_{day}$) with the addition of about 4.125 (mg $CO/_{day}$) from the P0 (control) treatment of 1.239 (mg $CO/_{day}$).

The high respiration process is due to the high activity of microorganisms, where microorganisms get energy through the respiration process. Microbial respiration is influenced by several factors, including humidity, temperature, oxygen, nutrient availability, and soil properties (Luo dan Zhou, 2006). According to Dariah *et al.* (2014), The average respiration rate of sapric peat is higher than hemic peat. This condition is caused by the availability of nutrients in sapric peat, which is higher than peat with lower maturity.

The high total population of soil microorganisms and high respiratory activity of microorganisms. This outcome corresponds to Wicaksono *et al*. (2015) literature which says that the activity of soil microorganisms is a process that occurs because of the life of microorganisms that carry out living activities in a soil mass. The activity of soil microorganisms is directly proportional to the total number of microorganisms in the soil. If the total number of microorganisms is high, the activity of microorganisms is also higher.

The high rate of respiration is positively correlated with a high population of bacteria which describes an increase in the rate of decomposition of organic matter. The increase in the decomposition rate of organic matter is due to land management in the form of drainage, which aims to reduce surface water (Notohadiprawiro, 2006). The reduction of surface water causes the decomposition rate of soil organic matter to increase because heterotrophic bacteria favor this condition, so the bacterial population also increases. (Bintang *et al.,*2005).

4. CONCLUSION

The addition of vermicompost fertilizer on peat soil with treatment two can increase the total bacteria by 6.17 x 106 cfu/ml, the total fungus by 8.8 x 105cfu/ml, and CO2 respiration by 4.125 (mgCO/day) so that the activity of soil microorganisms is a process that occurs because of the existence of microorganisms that carry out living activities in a soil mass

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