Development of technology vermicompost production for the coffee plant Industry

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Abstract, The aim of this study was to convert skin coffee (SC) amended with green waste (GW) and biochar (B) into vermicompost and evaluates their effects on the plant growth coffee. Biochar is a carbon rich product made from the rice husk pyrolysis process at 450°C, green waste eq branch cuttings and leaves from in the garden Universitas Negeri Jakarta and skin coffee from Cibulao coffee farm Bogor, Indonesia. Biochar was mixed with SC and GW in different proportion i.e., 6%, 8% and 10% b along with control and allowed to pass through earthworm guts during two months. Vermicompost was characterization with SEM EDX and chemical content. The 8% biochar addition rate achieved maturity of vermicomposting and resulted in the highest quality vermicompost based on parameters such as organic C, C:N ratio, total N, P, K content and pH, were compared to a vermicompost as control. in the cultivation of plant growth, physiological parameters and morphology plant coffee growth such as number of leaf, heigh plant, steam diameter and shoot dried weight.

1. Introduction
Vermicompost is organic fertilizer obtained through a process that involves earthworms in the process of decomposing organic waste. Organic waste will be broken down by worms, then followed by microbes. The composting process involving earthworms is known as vermicompost or vermicomposting, while the end result is called vermicompost. In the vermitechnology process, earthworms and microorganisms work together symbiotically to accelerate the decomposition of organic matter [1], increase the surface area, reduce the C/N ratio, modify the chemical, physical and biological properties of organic waste to facilitate microbial activity to produce vermicompost [2]. This technology is simple, efficient, and inexpensive [3]; it is a continuous, cost-effective process [4]. In addition to producing vermicompost, biomass is also produced in the form of worms [5]. Worms are a source of protein that can be used as fish feed [6], animal feed [7].

Compared to compost, vermicompost is more stable, has more nutritional content with a simpler structure so that it is easily absorbed by plants, does not contain toxic and odorless compounds [4], is free of pathogenic bacteria and is pollution free, and produces low greenhouse gases [8]. Kavita and Garg [3] studied the effect of cow dung, paper waste and rice straw on the ratio value of vermicompost. The results of the study show that by mixing 70% cow dung, 20% rice straw and 10% paper waste produces vermicompost with a C/N ratio of 12.24, much lower than using 90% cow
The results of the study by Najjari and Ghasemi [9] show that adding 10% blood powder to sawdust will produce vermicompost with a C / N ratio of 12.3, while without the addition of blood powder the C / N ratio is very large.

Moorthi et al [10] studied the effect of composting time and earthworm media on the quality of vermicompost produced from tea dregs and industrial solid waste. The results showed that the longer the composting time, the total organic carbon content decreased, while the nitrogen, phosphorus and potassium content increased. Suthar [4] (2009) reported that worm media containing biogas waste and market waste with a ratio of 1:2 produced vermicompost with N, P, K content respectively 31.3 kg / Kg, 8.7 g / Kg and 20.7 g / Kg and C / N ratios of 20. The results of Nazneen et al [11] showed that to produce vermicompost with high N, P, K content composting time required 40-60 days, while traditional composting takes 100 days. Using worms consisting of Eisenia fetida, Eudrilus eugeniae, and Perionyx produces better vermicompost quality than using worms consisting of Eisenia + Eudrilus or Eisenia + Perionyx.

Liu and Price [12] reported that making vermicompost from coffee grounds coupled with cardboard and E.fetida worms, can accelerate the composting time from 98 days to 47 days. Adi and Noor [13] (2009) reported that the formulation of raw materials for vermicompost affected worm weight and vermicompost quality. Krystina et al [14] (2016) reported that adding biochar to worm media could shorten composting time and accelerate worm growth and improve vermicompost quality. Increase enzymatic activity, accelerate the degradation of lignin [15].

Linee et al [16] reported that soil treated with vermicompost was able to produce 4.51 tonnes of cabbage / ha while the soil named NPK fertilizer produced cabbage 4.22 tonnes / ha. Likewise, tomatoes given vermicompost reached a height of 48 cm, while those given NPK fertilizer were 37 cm tall. Xiaoqiang et al [15] reported that geraniums given compost reached 39.98 cm high and 1.8 flowers, while those given vermicompost reached 54.74 cm in height and 3.6 flowers. In this study, coffee husks, biochar and dry leaves were used to make vermicompost and test the effect of vermicompost on the growth of coffee plants.

2. Methodology

2.1. Earthworm media
Earthworm media used in the experiment included biochar from spent coffee ground, skin coffee and cow dung. Skin coffee air-dried and cut into 1-2 cm length, and cow dung air dried 14 days to eliminate pathogenic bacteria. The composition of earthworm media is shown in Table 1.

| No | Skin coffee | Cow dung | biochar |
|----|-------------|----------|--------|
| 1  | 1           | 0.03     | 0      |
| 2  | 1           | 0.03     | 0.06   |
| 3  | 1           | 0.03     | 0.08   |
| 4  | 1           | 0.03     | 0.1    |

2.2. Composting
All initial mixtures were composted in 40 L composter with forced aeration for 14 days, and then used for vermicomposting. Composting was monitored by daily measurements of temperature and moisture.

2.3. Vermicomposting
Provide 4 wooden boxes with a length of 30 cm, a width of 20 cm and a height of 10 cm. and label it according to the compost formula. At the bottom, make a drainage hole with a diameter of 1 cm, then cover it with a parnet. Into each container add 500g of earthworm media. On the surface of the compost, distribute 25 E.fetida worms. cover the city with. Pay attention to the condition of the worms
for two days, if the worms stay healthy and chase, the media is suitable for use. The behavior of earthworms that roam on the media or run away, indicates incompatibility between earthworms and the media. the fix is to pour enough water on the media, then squeeze it until the juice looks clear. Media that has been repaired can be used again for cultivation. The new media can also be used to replace the unsuitable media. The worm feed is a thin layer that is placed on the surface of the medium in the form of blended vegetable waste pulp.

2.4. Media for growing coffee

After 7 days the worms will release their blackish brown dirt, also known as vermicompost. Vermicompost is taken using a cement spoon, stored in a plastic container or sack. The vermicompost is taken every three days. Earthworm activity, i.e survival rate, weight, and number of cocoons and juvenile earthworms, was monitored on week 0, 1, 2, 3, and 4. Organic N, P and K, C levels in vermicompost were analyzed at the Soil Research Institute, Bogor. Vermicompost whose quality meets SNI standards is then used for coffee nurseries.

3. Result and discussion

3.1. Characterization of Vermicompost

The results of the characterization of vermicompost by SEM are shown in Figure 1. SEM results showed that the vermicompost particles were agglomerated to form clusters with non-homogeneous structures (polymorphs).

![Figure 1 SEM of vermicompost](image)

The results of EDX analysis on vermicompost are shown in Figure 2. From Figure 2 it can be seen that vermicompost contains C (16.17%), O (56.21%), Al (10.96%), and Si (9.37%). Other elements such as Fe, Ca, Mg and Ti are also a constituent of vermicompost with a small composition.

![Figure 2. The Vermicompost EDX Spectrum](image)
3.2. Characteristics of earthworm media

The results of the analysis on the material for worm media are shown in Table 2

| No | Parameter   | Skin coffee | Cow dung | biochar |
|----|-------------|-------------|----------|---------|
| 1  | pH          | 6.21        | 7.74     | 7.82    |
| 2  | C organic(%)| 34.48       | 48       |         |
| 3  | N(%)        | 1.27        | 1.05     | 2.26    |
| 4  | P(ppm)      | 29          | 84.62    | 97.80   |
| 5  | K(ppm)      | 2.46        | 8.08     | 12.04   |
| 6  | C/N ratio   |             |          |         |

The high nutrient content in biochar is expected to increase the nutrient content in Vermicompost.

3.3. Characteristics of vermicompost.

The results showed that the earthworm media affected the chemical content and macro and micro elements in vermicompost, as shown in Table 3.

| No | Chemicals   | Compost+0%B | Compost+6%B | Compost+8%B |
|----|-------------|-------------|-------------|-------------|
| 1  | pH          | 5.36        | 5.48        | 5.60        |
| 2  | Organic     | 53.20       | 61.65       | 65.80       |
| 3  | Carbon organic | 26.30   | 34.50       | 36.40       |
| 4  | Nitrogen    | 2.70        | 2.50        | 2.76        |
| 5  | Sodium      | 1.73        | 1.29        | 1.32        |
| 6  | Potassium   | 3.48        | 3.62        | 3.84        |
| 7  | Calcium     | 51.46       | 52.70       | 56.00       |
| 8  | Magnesium   | 6.22        | 6.24        | 6.85        |
| 9  | Phosphor    | 28.42       | 28.90       | 32.74       |
| 10 | Zinc        | 2245        | 2264        | 2676        |
| 11 | Mangan      | 5.24        | 5.18        | 5.42        |

From Table 3 it can be seen that the N content is getting less, while the pH and organic C increase with the increase of biochar. By increasing C, the C / ratio also increases. Organic waste after becoming vermicompost, its mineral content increases with the increase in biochar content. This is because biochar contains organic carbon which is able to adsorb metallic metals from earthworm media.

3.4. Effect of earthworm media on the mass vermicompost

The weight of vermicompost obtained from various types of worm media and composting time is shown in Figure 3.
Effect earthworm media on mass vermicompost

Media containing 8% biochar produced more vermicompost than media that contained 4% biochar or did not contain biochar. As is known, biochar contains a low water content so that the level of shrinkage is only slightly, unlike the other two ingredients such as coffee skin and cow dung. From Figure 3 it is known that the composting time has a significant effect on the weight of the vermicompost produced, the composting time of 2 weeks gives the most vermicompost results, namely 469 g. This is due to the fact that in the second week the number of young worms increases, and with the increase in time the mother worms decrease, so that less Vermicompost is produced.

3.5. Effect vermicompost on growth of plant coffee

The highest height of coffee seedlings was in the EV20, but it was not significantly different from the EV15 treatment. The lowest plant height was in EC treatment and significantly different from other treatments as shown in Table 4.

| No | Sample | Composition                  | Height | Leaf |
|----|--------|------------------------------|--------|------|
| 1  | EC     | Soil + Compost               | 12.00  | 4    |
| 2  | EV10   | Soil + 5% Vermicompost       | 13.14  | 7    |
| 3  | EV20   | Soil +10% Vermicompost       | 15.24  | 11   |
| 4  | EV30   | Soil +15% Vermicompost       | 17.22  | 13   |
| 5  | EV20   | Soil +20% Vermicompost       | 18.86  | 15   |

EV5 treatment, soil containing 20% vermicompost, gave the best results against all variables observed. This is because in this composition there is more soil Contains Vermicompost Fertilizer. Vermicompost fertilizer can fertilize the soil through its influence on soil physical, chemical and biological properties. Physically vermicompost can: (1) affect soil texture, (2) improve soil structure, (3) improve soil consistency, (4) improve soil drainage, (5) improve soil pores, (6) soil maturity, (7) increase plant growth power, (8) loosening the soil so that the space for the roots will increase.

Chemically, vermicompost fertilizer: (1) contributes macro and micronutrients, (2) Vermicompost fertilizer can also increase soil reaction (soil pH), (3) improve soil colloids (mineral matter), (4) cation exchange capacity, (5) anion exchange (charged compound), (6) base saturation so that the availability of nutrients is getting better. Biologically, vermicompost can increase the population of soil microorganisms so that the soil becomes more fertile. Vermicompost also functions as a biological control tool in suppressing plant diseases, namely by inhibiting disease growth through natural processes by increasing competitive activity and antibiotics in the inoculum.
4. Conclusion
The treatment of media composition with coffee husk waste vermicompost had a significant effect on the variables of plant height and wet weight, and had a very significant effect on the variables of dry weight of coffee seedlings in the main nursery. The best media composition is P5 treatment, which is the media composition of one part of sub soil mixed with four parts of coffee husk waste vermicompost. The use of vermicompost fertilizer from coffee husk waste can substitute NPK inorganic fertilizer for coffee nurseries in the main nursery. It is recommended to use media with a composition of one part sub soil mixed with four parts vermicompost coffee husk waste in the robusta coffee nursery in the main nursery.

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