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Potential of Utilizing Arabika Coffee Dregs (*Coffea Arabica* L.) as Biochar for Increasing Fertility of Plant Media

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Abstract. *Coffee dregs biochar is an organic material that contains lots of nutrients for increasing soil fertility. The nutrient content in biochar is very good for plant growth. Research about the use of biochar from arabica coffee dregs (Coffea arabica L.) has been done to know its effectiveness in increasing the fertility of the planting medium. This research used a completely random design with a combination treatment consisting of 4 planting media mixtures. Treatment P 0 = Biochar: Compost coffee skin: Top Soil (0: 1: 2); P 1 = Biochar: Compost coffee skin: Top Soil (1: 1: 2); P 2 = Biochar: Compost coffee skin: Top Soil (1: 0: 2); P 3 = Biochar: Compost coffee skin: Top Soil (2: 1: 2); P4 = Biochar: Compost coffee skin: Top Soil (1: 2: 2); P5 = Biochar: Compost coffee skin: Top Soil (1: 1: 1). In the growth of Arabica coffee bud, treatment P1 showed best results at observation height plants (7.8 cm). Treatment P3 showed the best results at observation of total leaves (2.9). Treatment P1 showed the best results in the observation of leaves area (85.2 mm) and treatment P4 showed the best results in observing of stem diameter (2.4 mm). Treatment P1 also showed the best results for observation of wet weight (32.2 g) and dry weight (9.76 g). However, the control treatment showed best results on roots wet weight (7.41 g) and roots dry weight (2.07 g). Analysis results in nutrient content in processed coffee dregs biochar activated with coenzymes showed content element N: 1.45%; P: 223.45 mg; K: 3.54 mg; Ca: 21.78 mg; Mg: 2.56 mg. After the biochar is mixed with compost coffee skins and topsoil enhancement of nutrient content. Treatment combination is best shown by treatment P3 where element rate the highest elements N, P, K, Ca, and Mg compared to treatment other. Results showed that biochar combined in several types of planting medium is effective in increasing the fertility of the planting medium.*

Keywords: *Arabika, Biochar, Coffee Dregs, Soil Fertilizer.*

INTRODUCTION

Coffee dregs (*Coffea arabica* L.) are waste that contains sugar which is polymerized into cellulose and hemicellulose. Hemicellulose is composed of 3 sugars, namely mannose (21.2% w/w), galactose (13.8% w/w), and arabinose (1.7% w/w), while cellulose consists of glucose (8.6% b/b). Coffee dregs also contain proteins, namely glutamic acid, leucine, glycine, valine, phenylalanine, and alanine. Coffee dregs also contain ash which is formed by several minerals such as potassium, phosphorus, magnesium, and calcium (Tsai, 2017).

Coffee dregs are very complex because they contain a variety of chemical compounds, which shows that coffee dregs can be used for a variety of applications (Asfaw et al., 2019). Coffee dregs contain nitrogen so they can be used as fertilizer. Coffee dregs also have an oil content of around 10-20% so they can be used as raw material for making biodiesel. Coffee dregs can also be used as raw material for making adsorbents because they contain carbon which can be used to adsorb heavy metals such as Pb (Caetano et al., 2012).

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Zhang et al (2020) researched the use of adsorbents from coffee dregs waste to adsorb sulfonamide antibiotic liquid waste. Adsorption is carried out using coffee dregs which are synthesized through two methods, namely pyrolysis (biochar) and hydrothermal carbonization (hydrochar). The research results showed that the maximum adsorption capacity using coffee dregs biochar for sulfadiazine and sulfamethoxazole was 121.5 µg /g and 130.1 µg/g respectively, while the maximum adsorption capacity using coffee dregs hydrochar for sulfadiazine and sulfamethoxazole was 82 m respectively. .2 µg /g and 85.7 µg /g.

Biomass is organic material obtained from the photosynthesis process, either in the form of products or waste (Silakova, 2018). The advantage of using biomass as fuel is that it can reduce carbon dioxide levels in the atmosphere, this happens because biomass produces less residual gas from combustion, so it is more easily reabsorbed by plants (it is carbon neutral) (Mustamu & Pari, 2018). Biomass can be obtained from various sources, including agricultural waste and wood waste. However, biomass has high water content and poor flammability (Kansai et al, 2018; Lee et al., 2019).

Biomass waste that is quite potential and abundant in Indonesia is coffee dregs. Coffee consumption in Indonesia increases by an average of more than 7% every year (Adiwinata et al., 2021). so the higher the coffee consumption, the greater the amount of coffee waste produced from each cafe and household (Limantara et al., 2019). However, coffee dregs contain aromatic and aliphatic compounds, which when burned will produce a lot of smoke (Khusna & Susanto, 2015). Therefore, modifications need to be made to increase the potential utilization of coffee dregs by mixing coffee dregs with other biomass which may have a high calorific value (Blinova et al., 2017).

The large amount of coffee waste in the Bukit Lawang tourism area will give rise to various problems without being processed and utilized well. Yayasan Sayap Proyek Indonesia owns its vision for making Timbang Jaya Village, Bahorok District the biggest recycling village in the world, and has potential and supporting facilities to manage coffee dregs into biochar for enhancement fertility of the planting medium. One effort to overcome the abundance of coffee dregs is to use them as biochar. Based on the description above, research It is hoped that biochar from coffee dregs can be used as an alternative for increasing fertility soil in the planting medium arabica coffee (Coffea arabica L.) nursery. The results of this research will also impact positively the enhancement of productivity agriculture community in Bahorok District.

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RESEARCH METHOD(S)

This research was held on month November 2023 in Timbang Jaya Village, Bahorok District. The materials used in this research were coffee dregs, husks burn, compost, and topsoil. Tools used in the study are a soil pH meter, thermometer, polybag, hoe, machete, and burning drum. The seeds used in the test stage are ready coffee seeds 4 weeks old after plant.

This research was carried out using the CRD (Completely Randomized Design) method with 5 treatments with 3 replications. The treatment design given can be seen in the schematic below (Hanisah et al., 2020). The treatment consisted of 4 combinations of planting media P 0 = Biochar: Compost coffee skin: Top Soil (0: 1: 2); P 1 = Biochar: Compost coffee skin: Top Soil (1: 1: 2); P 2 = Biochar: Compost coffee skin: Top Soil (1: 0: 2); P 3 = Biochar: Compost coffee skin: Top Soil (2: 1: 2); P4 = Biochar: Compost coffee skin: Top Soil (1: 2: 2); P5 = Biochar: Compost coffee skin: Top Soil (1: 1: 1). Each planting medium This used in seeding mature coffee shoots 40 days old as test sample.

Normative legal research is also known as library research or document study. It is called library research or document study because this research is mostly carried out on secondary data in libraries, such as books and official documents from the government (Suratman and Dillah: 2013).

Producing of Coffee Dregs Biochar

The stages of making coffee dregs compost carried out by the author are as follows: 2 kg of coffee dregs are collected and air-dried for 3 days (according to the weather) to reduce the water content. Coffee dregs are then burned using a drum and closed for the pyrolysis process to happen in a way perfect. Coffee dregs that have become charcoal smoothed with the use of mortar. The coffee dregs are filtered and discarded part dregs roughly. The filtrate from charcoal This is what coffee dregs are called with biochar.

Activation of Coffee Dregs Biochar

Biochar has been filtered and activated with the use of coenzymes. Coffee dregs are poured with fluid coenzymes until wet and perfect. Mixture This is deposited for 2 hours, then rinsed with water to remove characteristic the acid and clean from the remainder of coenzymes.

Basic Analysis of Biochar Coffee Dregs

Biochar which has been formed then air-dried, pounded, and filtered until it passes through a 2 mm sieve. Basic analysis was carried out to analyze total N content, available P, K- dd, Na- dd, CEC, pH, C-organic, C: N ratio, and water content in the soil.

Analysis of Nutrient Content of Planting Media Mixture of Biochar, Compost, and Top Soil

Soil analysis in the laboratory is the research stage after taking samples in the field. This analysis is the chemical properties of the soil which include macronutrients (N, P, K, Ca, Mg, and S) and pH.

Observation Parameters

Parameters observed in the study This is the rate of Nutrients in biochar (N, P, K), levels of nutrients in the planting medium after treatment as well as growth of coffee shoots at 15 days of age after moving plant. In the growth of coffee shoots, the observation parameters observed are shoot height, number of leaves, stem diameter and area of leaves, heavy wet and heavy dry title, and heavy wet and heavy dry root.

FINDINGS AND DUSCUSSION

Influence Combination of Biochar Planting Media, Compost Coffee Skin, and Top Soil Against Growth of Arabica Coffee Shoots (*Coffea arabica* L.)

Observation of total plant height leaf, diameter stem and wide Coffee leaves were observed at 15 days of age after move planting (DAP). Recent observations of numbers of leaves, diameter stem, leaf area, leaf color, shoot fresh weight, shoot dry weight, root fresh weight, and root dry weight. Leaf area is done by measuring the length and width of the leaf and multiplying them with a mark constant leaf.

Table 1. Influence Biochar Composition, Coffee Dregs and Land to Tall Seeds, Amount Leaves, Leaf Area and Stem Diameter

Treatment (B: C: T)	Tall Seedlings (cm)	Amount Leaves (strands)	Wide Leaves (mm)	Stem Diameter (mm)
P0 = 0:1:2	6 ,6 ^{ab}	2 ,1 ^{a}	6 5 .8 ^{bc}	2.1 ^{a}
P1 = 1:1:2	7 ,8 ^{abc}	2 .6 ^{ab}	85,2 ^{abc}	2,1 ^{a}
P2 = 1:0:2	6,8 ^{ab}	2,3 ^{a}	61,8 ^{ab}	1,9 ^{a}
P3 = 2:1:2	5,9 ^{a}	2,9 ^{abc}	56,7 ^{bc}	2,3 ^{ab}
P4 = 1:2:2	5,9 ^{a}	2,3 ^{a}	59,1 ^{bc}	2,4 ^{abc}
P5 = 1:1:1	7,6 ^{ab}	2,6 ^{ab}	60,6 ^{bc}	1,9 a

B: Biochar C: Compost T: Top Soil

Biochar composition and coffee dregs to tall seeds, amount of leaves, leaf area, and stem diameter are presented in Table 2. At age 15 days after moving the plant tall Arabica coffee

seedlings range from 6.7 cm, the number of leaves ranges from 2-3 leaves and the diameter stem ranges from 1.9-2.4 mm. Composition of biochar, compost of coffee skins, and soil influence leaf area as shown by the variable length x width of the leaf where a composition of 1:1:2 gives the widest coffee leaves.

Influence Combination of Biochar Planting Media, Compost Coffee Skin, and Top Soil on Wet Weight and Dry Weight of Arabica Coffee (*Coffea arabica* L.)

Biochar and coffee dregs composition on fresh weight and dry weight of shoots, as well as fresh weight and dry weight of seedling roots, is presented in Table 2. The fresh weight of the seedling crown ranges from 21-29 g. The composition of the media influences the dry weight of the seedling crown.

Table 2. Influence Composition Biochar, Coffee Skin, and Topsoil to Weight Fresh and Shoot Dry Weight, as well as Fresh Weight and Root Dry Weight of Seedlings

Treatment (B: K: T)	Weight Fresh Header (g)	Weight Header Dry (g)	Weight Fresh Roots (g)	Weight Dry Roots (g)
P0 = 0:1:2	2 8,8 ^{BC}	7.74 ^{ab}	7,41 ^{abc}	2,07 ^{abc}
P1 = 1:1:2	32,2 ^{abc}	9,76 ^{abc}	5,34 ^{ab}	1,42 ^{ab}
P2 = 1:0:2	25,3 ^{ab}	8,67 ^{bc}	5,76 ^{ab}	1,70 ^{ab}
P3 = 2:1:2	22,8 ^{ab}	8,65 ^{bc}	4,76 ^{a}	1,30 ^{ab}
P4 = 1:2:2	26,6 ^{ab}	7,90 ^{ab}	4,56 ^{a}	1,12 ^{ab}
P5 = 1:1:1	21,6 ^{a}	6,41 ^{a}	3,67 ^{a}	1,07 ^{a}

B: Biochar C: Compost T: Top Soil

The 1:1:1 composition produces the lowest dry weight of the seedling crown. The composition of biochar, coffee dregs, and topsoil influences root growth. Medium with composition biochar, coffee dregs, and topsoil 0:1:2 produces the highest fresh root weight but is not different real with compositions 1:1:2 and 1:0:2. Medium with composition biochar, coffee dregs, and topsoil 0:1:2 produces a higher root dry weight compared to 1:1:1 However not significantly different from the composition 1:1:2, 1:0:2, 2:1:2 And 1:2:2. Mixing biochar with a composition of 1:1:2 reduces root growth.

Content Macro and Micro Nutrients in Coffee Dregs Biochar

Analysis results in content element macro N, P, K, and Mg as well element Micro Ca in activated coffee dregs biochar with fluid eco enzymes can seen in Table 3 below this:
Content element macro highest is the P element dominates with highest 223.54/ 100 gr

sample. Element levels lowest in Arabica coffee dregs biochar is element N with a total of 2.15%.

Table 3. Content Nutrients in Arabica Coffee Dregs Biochar (100 gr sample)

Nutrient	Total
N (%)	1.45
P (mg)	223.45
K (mg)	3.54
Ca (mg)	21.78
Mg (mg)	2.56

Results of technical analysis in the laboratory on the concentration of macronutrients N, P, K, Ca, and Mg on the composition of the planting medium that has been used mixed with biochar can be seen in Table 5. Analysis done with 100 grams of planting media samples. N and Mg nutrient content in all treatments looks low.

Table 4. Nutrient Levels in Planting Media Combination of Biochar, Compost Coffee Skins and Top Soil

Treatment (B: K: T)	N (%)	P (mg/100 g)	K (mg/100 gr)	Ca (mg/100g)	Mg (mg/100 gr)
P0 (0:1:2)	2,54	134,56	5,67	15,87	3,75
P1 (1:1:2)	2,78	267,34	6,35	14,98	3,47
P2 (1:0:2)	2,65	245,87	6,29	15,34	4,01
P3 (2:1:2)	2,81	321.95	7.56	17.45	5.45
P4 (1:2:2)	2,67	245.45	6.34	16.56	4.76
P5 (1:1:1)	2,37	234.76	6.87	15.45	3.87

B: Biochar C: Compost T: Top Soil

Discussion

From the results of the tests that have been carried out, you can It can be seen that the nitrogen yield in each treatment is around 2.37-2.81% This result is above the standard determined by SNI 19-7030-2004, namely 0.40% For ideal nutrient content in planting media. The highest nitrogen yield was in the P3 treatment with a percentage yield of 2.81% and the lowest at P5 was obtained at 2.37 %. It can be seen that the nutrient content obtained has met national standards. This is because nitrogen is a stable gas so it does not easily react into other compounds. Apart from that, nitrogen is generally a colorless, odorless, and tasteless gas. So that the results obtained can reach more than the national standards used (Nguyen, 2016). The differences in the results of N-total, phosphorus, and potassium are caused by differences in

the availability of nitrogen which takes place in the decomposition process of organic matter (Hwang et al., 2021).

On observation of the growth of Arabica coffee seeds, available also seen that happen very significant improvement against parameters plants, extensive leaf and stem diameter. Enhancement This happens Because of the composition of the ideal planting medium so that enhancement rate nutrient. One way to increase the nutrient content in the soil is by adding biochar and compost. Apart from being environmentally friendly, this method is also able to reduce production costs and increase the quality and quantity of agricultural products (Cubero et al, 2014). With high levels of nutrients, plants will grow well. The mechanism of nutrient availability can be through the process of root interception in plants where plant roots grow and develop occupying the space originally occupied by the absorbed nutrients, plant roots grow freely and absorb nutrients so that plants can grow and develop well (Neina, 2019)

Organic matter also plays a very important role as a source of energy and food for soil microbes so that it can increase the activity of these microbes in providing plant nutrients (Tsaniyah & Daesusi, 2020). Nitrogen (N), phosphorus (P), and potassium (K) are nutrients that are needed by plants, especially in corn plants in very large quantities. Nitrogen is an important element in the formation of chlorophyll, protoplasm, proteins, and nucleic acids. Soil nutrients are generally found in abundance in the top layer of soil (topsoil), especially the nutrients N, P, and K as plant fertilizers, so that surface flow that occurs apart from soil erosion also carries soil nutrients out of agricultural land plots (planting plots) (Sinaga et al. 2017).

Nutrients are one of the factors that can support plant development and growth. Every plant needs nutrition (food) to survive. The nutrients nitrogen, phosphorus, and potassium play an important role in large quantities (Heo and Park, 2022). There is sufficient nitrogen in the soil if the plant grows well, where the leaves are greener, if the leaves are yellowish, then plant growth is stunted and development will fail, the plant experiences a nitrogen nutrient deficiency (Triastinurmiatiningsih 2019).

CONCLUSION AND RECOMMENDATION

The combination of biochar planting media, coffee grounds, and soil affects the number of leaves, leaf area, and dry weight of the canopy. The addition of biochar to the planting medium is effective in increasing soil fertility.

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