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Chemical Properties of Biochar from Date Palm Seed (*Phoenix dactylifera* L.) under Low Temperature Pyrolysis as Soil Amendment Candidate

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ABSTRACT

The waste of date palm seeds is abundant in Indonesia, however, the seeds are still regarded as trash from the manufacture of date palm-based products. Dates seed, when processed further, can be a useful resource, one of which is as a raw material in the production of Biochar. The utilization of date palm seeds into biochar is one strategy that can be applied. The purpose of this study was to determine the chemical properties of biochar derived from the seeds of palm date (Phoenix dactylifera L.). Making biochar is done by burning the seeds using a furnace with a temperature of 250°C and 350°C, then ground and sieved with a size of 355 micrometers carried out at the Research Center for Limnology and Water Resources. Chemical property analysis using X-Ray Fluorescence Spectrometer (XRF) at the Lampung Advanced Characterization Laboratory- BRIN. The results show there are four macronutrients found in date palm seed biochar namely P, K, Ca, and S. Most composition is Potassium (K). The potassium content of biochar burned at 250 °C is 66.24% while the biochar burned at 350 °C contains 67.189%. In addition, the phosphorus (P) content of biochar burned at a temperature of 250 °C is 6.574% while the biochar burned at a temperature of 350 °C contains 7.429%. Increasing the temperature increases the percentage of Potassium and Phosphorus, but the opposite results in Sulfur (S) and Calcium (Ca).

1. Introduction

The date palm (Phoenix dactylifera L.) is an important member of the Palmaceae family that is farmed in dry and semi-arid regions around the world **(Saafi *et al.*, 2008)**. People in date-producing countries rely heavily on the date palm for their economic and social well-being **(Basuni & AL-Marzooq, 2010)**. Dates are become part of Indonesian citizens due to their great nutritional value **(Warnasih *et al.*, 2019)**, they are also used in Muslim religious rituals, especially in the holy month of Ramadan.

Indonesia imports many different types of dates. Dates are utilized as a raw ingredient in the production of date juice in Indonesia, in addition to being a ready-to-eat dish. There is some waste produced in the form of date seeds during the manufacture of date palm juice. In many nations across the world, the accumulation of agricultural industry wastes is regarded as a significant environmental problem, particularly in areas where there are no waste recycling plants or where workers lack the necessary skills to finish the recycling process. Date seeds are one of these types of plant debris. Date seeds are a type of dry waste that is lightweight and large in size (i.e. low density and quality), and these wastes have collected in enormous amounts, posing a serious concern because they are a source of pollution when burned, as well as a home for rodents and insects **(Al-Mosawi *et al.*, 2018)**. The waste of date palm seeds is abundant in Indonesia, however, the seeds are still regarded as trash from the manufacture of date palm-based products. Dates seed, when processed further, can be a useful resource, one of which is as a raw material in the production of Biochar.

Biochar is a carbon-rich substance made from organic wastes like agricultural waste. It is a high-value substance that can be utilized as a soil amendment and in energy generation to help mitigate climate change **(Kloss *et al.*, 2012)**. The purpose of this research is to study chemical properties of biochar from date palm seed (*Phoenix dactylifera* L.) under low temperature pyrolysis as soil Amendment candidate.

2. Methods

Producing biochar is done by burning the seeds using a furnace at a temperature of 250 °C and 350 °C for 4 hours following the protocol carried out by **Septiana *et al.* (2018)**, then milled and sieved to a size of 350 micrometers carried out at the Research Center for Limnology and Water Resources. Analysis of chemical properties using X-Ray Fluorescence Spectrometer (XRF) using Omnian ED-XRF Panalytical Epsilon 3 XLE at Lampung Advanced Characterization Laboratory-BRIN. The data were analyzed descriptively by comparing the chemical content of biochar which was burned at temperature 250 °C and 350 °C.

3. Results and Discussions

Agricultural waste is a type of biomass with a lot of promise if properly managed. Biomass can be used as a starting material for pyrolysis, which can produce liquid, gaseous, and solid fuels. Over the last three decades, pyrolysis conversion technology for biomass has been studied and is now employed commercially **(Bridgwater *et al.*, 2002).**Pyrolysis creates gas, vapor, and solid char, which can be recovered as liquid or solid. Converting biomass into Biochar through the pyrolysis process is one of the possibilities.

The Figure 1. Show the condition of the raw material and the biochar after burning 250 °C and 350 °C.for 4 hours. The chemical properties can be seen in Table 1. In Table 1 there are 11 elements were found in the biochar that was analyzed using XRF. The element are Phosphor (P), Sulfur (S), Potassium/ Kalium (K), Calcium (Ca), Manganese (Mn), Iron/ Ferro (Fe), Copper/ Cuprum (Cu), Zinc (Zn), Bromine (Br), Rubidium (Rb), Strontium (Sr). From that elements P, S, K, and Ca are

macronutrients for plants. Mn, Fe, Cu, and Zn are micronutrients for plants, however, those elements also can be toxic to plants and the environment such as heavy metal pollution in the soil.

Figure 1. The raw material and the biochar after burning

Table 1. Chemical properties of date palm seed biochar under different temperatur of burning

No	Element	Date Plam Seed Biochar Burn under 250 C	Date Plam Seed Biochar Burn under 350 C	Difference	Unit
1	P	6.574	7.429	0.855	%
2	S	4.123	3.604	-0.519	%
3	K	66.240	67.189	0.949	%
4	Ca	20.457	16.625	-3.832	%
5	Mn	0.607	0.650	0.043	%
6	Fe	0.874	0.943	0.069	%
7	Cu	0.287	0.292	0.005	%
8	Zn	0.540	0.615	0.075	%
9	Br	649.6	668.3	18.7	ppm
10	Rb	795.2	926.9	131.7	Ppm
11	Sr	0.155	0.137	-0.018	%

From table 1. The main chemical content is potassium then calcium. The potassium content of biochar burned at 250 °C is 66.24% while the biochar burned at 350 °C contains 67.189%. In addition, the phosphorus (P) content of biochar burned at a temperature of 250 °C is 6.574% while the biochar burned at a temperature of 350 °C contains 7.429%. But the opposite result for Sulfur and Calcium, The sulfur content of biochar burned at 250 °C is 4.123% while the biochar burned at 350 °C contains 3.604%. The calcium content of biochar burned at a temperature of 250 °C is 20.457% while the biochar burned at a temperature of 350 °C contains 16.625%. Of 11 elements only 3 elements namely S, Ca, and Sr when the temperature increases the concentration will decrease. The other 8 elements will increase the concentration when the temperature increased. Increasing the concentration of potassium (K) and phosphorus (P) following the increasing the temperature was similar to the research results by Septiana et al. (2018) with the sample Sawdust of albazia wood, Sawdust of maesopsis

wood, Sawdust of mahogany wood, Rice husk, Corn cob, Empty oil palm fruit bunch, Bagasse. This is in line with the findings of **Novak *et al.*, (2009)**, who found that as the temperature was raised, the concentration of elements inside the biochar increased, making them more resistant to vaporization.

Biochar is not compost, however, when the concentration of elements is compared to the National Standard of Compost for Indonesia (SNI) the concentration is Phosphor (P), Sulfur (S), Potassium/ Kalium (K), Calcium (Ca) was met of the match with Indonesian quality standard of compost. Moreover, based on the chemical properties the biochar from date palm seed has a high potential to be soil amendments.

4. Conclusions

Most composition is Potassium (K). The potassium content of biochar burned at 250 °C is 66.24% while the biochar burned at 350 °C contains 67.189%. In addition, the phosphorus (P) content of biochar burned at a temperature of 250 °C is 6.574% while the biochar burned at a temperature of 350 °C contains 7.429%. Increasing the temperature increases the percentage of Potassium and Phosphorus, but the opposite results for Sulfur (S) and Calcium (Ca). Based on the chemical properties the biochar from date palm seed has a high potential to be soil amendments.

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6. Authors Note

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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