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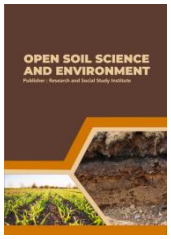

X-Ray Fluorescence Analysis of *Aquilaria malaccensis* Wood Sawdust Biochar Prepared under Low-Temperature Pyrolysis

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ABSTRACT

One of abundant waste in timber industry is *Aquilaria malaccensis* (Gaharu) wood Sawdust. To control this problem *Aquilaria malaccensis* wood Sawdust can be used as biochar which will be useful for soil improvement. The purpose of this study was to determine the elemental content of biochar derived from the *Aquilaria malaccensis* wood Sawdust. Making biochar is done by burning the sawdust 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 Limnology and Water Resources Research Center. Element property analysis using X-Ray Fluorescence Spectrometer (XRF) at the Lampung Advanced Characterization Laboratory-BRIN. Based on the results of the analysis using XRF showed that the highest elemental content of biochar is Calcium (CaO) around 78-84%, Phosphorus (P_2O_5) around 4-5%, then Potassium (K_2O) around 2%. Based on element content biochar from *Aquilaria malaccensis* have high potential as soil amendments.

1. Introduction

Gaharu wood or Agarwood (*Aquilaria malaccensis*) is one type of wood that has a high economic value. Garahu wood can produce a resin that has benefits. Agarwood can be extracted to produce essential oils that have a distinctive aroma and are generally used as perfumes, cosmetics, incense to preservatives in various accessories (Balfas, 2008). In the process of processing agarwood, it is undeniable that it will produce waste in the form of sawdust. The sawdust produced does not have a high economic value, even if it is not managed it can cause pollution in the surrounding environment.

The problem of environmental pollution if ignored will have a big impact in the future. To minimize the impact of sawdust pollution, one way is to convert it into biochar troughs thermoelement processes. Gasification, pyrolysis, and hydrothermal liquefaction/ carbonization are common thermoelement processes for converting biomass into fuel, and biochar is a byproduct of all these conversion processes (Kim *et al.*, 2012).

Biochar is a solid material made from pyrolyzed biomass in low-oxygen conditions (Placido *et al.*, 2016); it is high in carbon and is applied to soil to improve its qualities (Lehmann & Stephen, 2015).

The quality of biochar depends on the raw material and the process of pyrolysis. The aims of this research are to analysis the element content of Gaharu wood Sawdust derived biochar under different temperature of pyrolysis.

2. Methods

Biochar is created by burning Gaharu wood sawdust in a furnace at 250 °C and 350 °C for 4 hours, then milling and sieving to a size of 350 micrometers at the Research Center for Limnology and Water Resources (Rahmat, 2021, Rahmat et al., 2022a, Rahmat et al., 2022b, Rahmat et al., 2023a, Rahmat et al., 2023b, Rahmat et al., 2023c, Rahmat et al., 2023d). X-Ray Fluorescence Spectrometer (XRF) analysis using Omnian ED-XRF Panalytical Epsilon 3 XLE at Lampung Advanced Characterization Laboratory-BRIN. The data were analyzed descriptively by comparing the element content of biochar burned at temperatures of 250 and 350 degrees Celsius.

Fig. 1 Raw material of Gaharu sawdust

3. Results and discussion

Non-food based biomass, such as wood wastes, waste paper, sawdust, grass, and biomass-derived char (biochar), is viewed as a promising feedstock for renewable and alternative fuels (Li *et al.*, 2011). Gaharu wood waste is a lignocellulosic biomass source with the potential to improve soil conditions by being converted into biochar and applied to the soil. From the Figure. 1. Can be seen that the color was change after pyrolysis process.

Figure. 1 Biochar from Gaharu sawdust

Table 1. Elemental content of biochar under different temperature of pyrolysis.

No	Element	Biochar Burn under 350 C	Biochar Burn under 250C	Difference	Unit
1	CaO	84.813	78.987	5.826	%
2	P_2O_5	4.208	5.870	-1.662	%
3	Fe2O3	4.522	4.067	0.455	%
4	K_2O	2.794	2.825	-0.031	%
5	SiO_2	1.388	2.083	-0.695	%
6	Al_2O_3	0.897	1.069	-0.172	%
7	TiO_2	0.433	0.547	-0.114	%
8	SrO	0.198	0.187	0.011	%
9	ZnO	0.184	0.132	0.052	%
10	CuO	0.123	0.120	0.012	%
11	MnO	0.130	0.111	0.019	%
12	ZrO2	0.0125	0.0158	-0.0032	%

From Table 1. The main element content is calcium then phosphorus. The calcium content of biochar burned at 250 °C is 78.987% while the biochar burned at 350 °C contains 84.813%. The phosphorus (P) content of biochar burned at a temperature of 250 °C is 5.870% while the biochar burned at a temperature of 350 °C contains 4.208%. In addition, The Potassium (K) content of biochar burned at a temperature of 250 °C is 2.825% while the biochar burned at a temperature of 350 °C contains 2.794%.

From Table 1, elements 6 elements namely CaO, Fe_2O_3, SrO, ZnO, CuO, and MnO when the temperature increases the concentration will increase, however only CaO the increasing concentration of elements by more than 1%. The other 8 elements will decrease the concentration when the temperature increases. In case of CaO, was in line with the findings of Novak et al., (2012), who found that as the temperature was raised, the concentration of elements inside the biochar increased, making them more resistant to vaporization. The effect of temperatures of pyrolysis in this research cannot reveal a strong correlation between the temperature with element content, and need more variations of temperature not only 250 °C and 350 °C.

Biochar was containing Calcium (Ca), Phosphor (P), Potassium/ Kalium (K). Where in future through mineralization that element can be released as a nutrient. On the other hand, Ca and K are cation and alkaline that have huge potential to increase pH in acidic soil by the liming process. Moreover, based on the element properties the biochar from *Aquilaria malaccensis* sawdust has a high potential to be soil amendments.

4. Conclusions

The most element content of *Aquilaria malaccensis* sawdust biochar composition is Calcium (CaO). The calcium content of biochar burned at 250 °C is 78.987% while the biochar burned at 350 °C contains 84.813%. In addition, the phosphorus (P) content of biochar burned at a temperature of 250 °C is 5.870% while the biochar burned at a temperature of 350 °C contains 4.208%. Only CaO concentration increase following the increasing the temperature. Based on the element content the biochar from gaharu wood or agarwood has a high potential to be soil amendments.

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6. Authors Note

In this article Ali Rahmat is main author /main contributor.

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