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Chemical Properties of Salacca Seed Biochar Under Low Temperature of Pyrolysis

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ABSTRACT

Salak or Salacca fruit is a seasonal fruit; in some cases, this fruit easy rotten due to a lack of handling during the harvesting process or wet or humid storage. This condition will promote much waste because the fruit cannot be eaten. To minimize the waste, the seed of salak fruit can be converted to biochar. This study aimed to determine the chemical properties of biochar derived from the seeds of salacca (Salacca zalacca). The biochar is produced by burning the seeds using a furnace with a temperature of 350°C and 450°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 that most composition is Potassium (K). Potassium (67-70%) is the most abundant element in Salacca seed biochar, followed by chlorine. Biochar burned at 350 °C has a potassium content of 70.25%, while biochar burned at 450 °C has a potassium content of 67.86%. Biochar burned at 350 °C has a chlorine content of 25.35%, while biochar burned at 450 °C has a chlorine content of 24.66%. The percentage of potassium and chlorine decreases as the temperature rises. Furthermore, the phosphorus (P) and calcium (Ca) content of biochar appear at biochar burned at 450 °C.

1. Introduction

Salak (*Salacca zalacca*) is one of the tropical fruits in Indonesia. Indonesian people consume the flesh of the salak fruit, which tastes sweet and sour with a crunchy texture, while the bark fruit and seeds of the fruit become waste. The portion of salak seeds is 25-30% of the total salak fruit, while the bark fruit of the salak fruit is only 10-14% **(Surbakti & Barus, 2022)**. Based on the comparison, the salak seeds have a great opportunity to explore more practical and economically viable materials. The utilization of salak seed waste is still not given much attention because of its rough and hard shape **(Zamroni et al., 2018)**. One of the uses of salak seeds is to convert the salak seeds into biochar as a soil amendment.

Biochar is a solid product of pyrolysis of carbon-rich biomass (65-90%) with a porous structure of charcoal particles that improves soil water retention and nutrient retention, as well as microbial accumulation **(Qambrani et al., 2017)**. The use of biochar is determined by its physicochemical properties **(Jindo et al., 2014)**. These properties, in turn, are determined by the feedstock and the pyrolysis or gasification conditions **(Jindo et al., 2014; Sun et al., 2014)**. This research aimed to determine the chemical composition of salak/salacca seed biochar at various pyrolysis temperatures.

2. Methods

The seeds are burned in a furnace at 350 °C and 450 °C for 4 hours according to the protocol developed by **Rahmat (2021)**, then milled and sieved to a size of 355 micrometers at the Research Center for Limnology and Water Resources. 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 chemical content of biochar burned at temperatures of 250 and 350 Celsius.

3. Results and Discussions

Biochar is an effort to manage organic waste that encourages optimizing degraded land **(Nurida, 2014)**. **Ogawa (2006)** explained that the quality of biochar is strongly influenced by the chemical properties of the raw materials and the carbonization method (temperature). The characteristics of the biochar content of salak seeds with various temperatures in the combustion process (pyrolysis) are listed in table 1.

From X-Ray Fluorescence Spectrometer, there are five main elements detected in salacca seed biochar, namely potassium (K_2O), Chlorine (Cl), Sulfur (SO_3), Phosphor (P_2O_5), Iron (Fe_2O_3). Compared with biochar from date seed, the chemical content in the term of macronutrients in salacca seed biochar was lower than biochar from date seed. **Rahmat (2021)** reported that Date seed biochar contains potassium, Calcium, Sulfur, Phosphor.

The study's results showed that the difference in temperature used in the pyrolysis process affected the availability of nutrients in the characteristics of biochar. The data shows that combustion below 350°C has a higher nutrient content of potassium (K_2O) than burning biochar at a temperature of 450°C. **Goenardi & Santi (2017)** explain that the use of different temperatures in combustion will produce different biochar characteristics. **Basu (2010)** explained that the composition of lignin and cellulose affects the different pyrolysis temperatures of each material used in the biochar manufacturing process. **Girsang et al. (2015)** added that salak seeds have a high cellulose content. **Herlambang et al. (2020)** explained that the temperature used to decompose biomass with a high cellulose content is 275 – 350°C. The high temperature used will result in low charcoal produced. Increasing the temperature of pyrolysis will decrease the concentration of potassium and chlorine.

Table 1. Chemical properties of salacca seed biochar under different temperatur of furnace

No	Parameter (unit)	Burning at 450^0C	Burning at 350^0C
1	K_2O (%)	67.866	70.253
2	Cl (%)	24.667	25.356
3	SO_3 (%)	3.491	3.457
4	P_2O_5 (%)	3.018	-
5	Fe_2O_3 (%)	0.352	0.250
6	ZnO (%)	0.136	0.170
7	CuO (%)	0.0749	0.1050
8	Rb_2O (%)	0.221	0.0750
9	MgO (ppm)	561.1	-
10	SnO2 (ppm)	474.5	633.2
11	MnO (ppm)	337.7	380.2
12	SrO (ppm)	106.5	132.2
13	Br (ppm)	104.2	105.0

Increasing pyrolysis temperature, the Potassium (K_2O) concentration decreases. However, at a temperature of 450°C, phosphorus (P_2O_4) and Magnesium (MgO) content appears. This shows that the reaction of each raw material to the pyrolysis temperature is different depending on the raw material itself.

4. Conclusions

Potassium (67-70%) is the most abundant element in Salacca seed biochar, followed by chlorine. Biochar burned at 350 °C has a potassium content of 70.25%, while biochar burned at 450 °C has a potassium content of 67.86%. Biochar burned at 350 °C has a chlorine content of 25.35%, while biochar burned at 450 °C has a chlorine content of 24.66%. The percentage of potassium and chlorine decreases as the temperature rises. Furthermore, the phosphorus (P) and calcium (Ca) content of biochar appear at biochar burned at 450 °C.

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6. Authorship

Ali Rahmat is main contributor in this article.

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