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Characterization of Palm Frond Biochar and Coconut Shell Biochar on Peaty Soil Physical

Ike Ramadhona*, Hapsoh, Besri Nasrul
Universitas Riau
Jln. Kampus Bina Widya KM. 12,5, Simpang Baru, Kec. Tampan,
Kota Pekanbaru, Riau 28293, Indonesia
*Email: ike.ramadhona7098@grad.unri.ac.id

ABSTRACT

Using plantation crop residues in the form of oil palm fronds and coconut shells has the potential as a soil ameliorant material such as Biochar. Using Biochar as an ameliorant can improve soil fertility, one of which is peaty soil with a very acidic pH. The research aims to analyze the basic characterization of Biochar palm fronds and coconut shells on the physical properties of peaty soil. Palm fronds and coconut shells were pyrolyzed using a simple combustion device in the form of a pyrolysis drum. Combustion with pyrolysis drums is carried out in a closed manner in the absence of oxygen for 2-5 hours. Parameters observed were lignocellulose of palm fronds and coconut shells, spectrographs, chemical properties of Biochar of palm fronds and coconut shells, and physical properties of peaty soil after applying Biochar of palm fronds and coconut shells. The pH, total C, total N, C/N, total P, available P, total K, total Na, and the volume and pore size of the coconut shell biochar showed higher results than the palm frond biochar. However, the results of the analysis of total Mg, total Ca, CEC and ash content and surface area on palm frond biochar showed higher results than coconut shell biochar. The moisture content and BD values of peaty soil in applying coconut shell Biochar showed the best results compared to palm frond biochar.

Keywords: *Oil palm frond biochar, coconut shell biochar, peat*

1. INTRODUCTION

Biochar (Biomass Charcoal), or what is commonly known as charcoal, is one of the most widely used soil amendments today. Biochar is produced through the combustion or pyrolysis of biomass under conditions with limited oxygen. Biochar is composed of aromatic carbon rings, making it more stable and long-lasting so that it can serve as a carbon reserve in the soil..

According to (Balai Penelitian Tanah, 2015), the characteristics of the Biochar produced were particularly those of agricultural detritus. Depending on the type of raw material used, the combustion temperature, and the combustion equipment, the quantity of charcoal produced in single combustion ranges from 22 to 53.5%. Due to the impact of temperature on Biochar production, the duration of smoldering with the same combustion device can result in varying Biochar yields..

Depending on the type of Biochar, the size of Biochar, the process of making Biochar (Pyrolysis and temperature), and soil conditions, particularly soil type and redox potential, Biochar can increase soil fertility, crop production and enhance the environment. Certain soil types may be suitable for one variety of Biochar, but not others. Biochar varieties that can be utilized include rice husk, Galam, coconut shell, and palm fronds.

Coconut shells and palm fronds are readily available in the community. Coconut shells can be found in markets as well as in household garbage. Additionally, oil palm fronds are abundant on the plantations of independent smallholders and corporations. Where the palm fronds themselves are often found in dead nets and palm oil plant waste, this one can be obtained very easily without going through a company because the farmers own the oil palm plants personally, where the decayed palm frond waste is typically trimmed from the plants and where the fronds are stored near the homes of local residents so that they can be used as firewood. Oil palm plant detritus from crops, including empty fruit bunches and oil palm kernel shells, must be legally submitted to the company to be obtained. Biochar is a well-known soil amendment that can improve soil properties. As a result of its relatively high pH and cation exchange capacity (CEC), Biochar functions as a soil ameliorant. According to laboratory research (Firmansyah, 2010), Biochar made from wood, rice husks, and coconut shells had pH values of 8.94, 6.34, and 9.0, respectively.

According to (Mahmood et al., 2015), Biochar's surface area and adsorption capacity from oil palm fronds were significantly greater than Biochar from oil palm shells and empty fruit clusters. The potential for using this type of Biochar from palm fronds for fuel and soil amendment applications is deemed high based on a study characterizing Biochar derived from residual palm oil. The results of this investigation indicate that Biochar from oil palm fronds is an effective acid-reducing agent for peat soil.

According to the study's findings (Mu'arif, 2021), applying oil palm frond Biochar can alter the physical properties of PMK soil. This is evident by the decrease in yield of the finest soil bulk density, which is 1.00 gram/cm3, the increase in soil porosity, which is 53.40 percent, and the increase in soil water content, which is 40.7 percent. The change in soil texture from clay to granular loam and adding Biochar causes a change in soil color from red to dark yellowish brown. According to the study's findings (Agviolita et al., 2021), the application of coconut shell Biochar had the maximum surface area value, influencing soil water absorption. Anita et al. (2016) found in (Agviolita et al., 2021) that the application of coconut shell Biochar can increase the proportion of water absorption more than Biochar made from other basic materials.

Researchers have therefore conducted a fundamental characterization study of oil palm frond biochar and coconut shell Biochar on the physical properties of peat soils.

2. MATERIAL AND METHODS

The study was conducted on peatlands in Tualang Village, Siak Province. From May to September of 2022, a four-month field study was conducted. In addition, the Soil Laboratory of PT. Arara Abadi has conducted research on the physics and chemistry of Biochar and the physics of soil for two months, from August to September 2022.

Peat soil materials and several chemicals used for chemical analysis in the laboratory were utilized in this investigation..

This study utilized a measuring tape, rapia rope, pyrolysis cylinder, cutter knife, markers, scissors, hoes, stationery, a camera, and a ring sampler. Ovens, filters, shakers, fortex, analytical scales, pH meters, spectrophotometers, flame photometers, AAS, ICP, hot plates, and other laboratory equipment are used as analytical instruments.

Laboratory research using the gravimetric method for soil physics analysis (moisture content and bulk density), Munsell soil color chart (soil color), dry ashing (lignin, cellulose, hemicellulose and ash content), pH meter (pH), combustion (C- total and N-total), HClO4 + HNO3 (total P and K-total), Bray–1 (available P) and NH4Oac Extract pH 7.0 (CEC and exchangeable bases such as K, Ca, Na, Mg).

3. RESULT AND DISCUSSION

Physical Characteristics of Peat Soil before Treatment

Based on the results of the analysis of physical properties of the peat soil before the treatment were analyzed at the Soil Laboratory of PT. Arara Abadi below presents a summary of the physical properties of peat soil before treatment in Table 1.

Table 1. Physical Characteristics of Peat Soil before Treatment

Parameter	Unit	Analysis Result
Soil Physical Properties		
Water content	%	47,86
Content Weight	g/cm^3	0,69
Soil Color		10 YR 2/1

Characteristics of Chemical and Physical Properties of Biochar Palm Oil Fronds and Coconut Shells

The results of the analysis of the chemical and physical properties of Biochar of palm fronds and coconut shells are presented in Table 2.

Table 2. Chemical properties of Biochar

Parameter	*Biochar Type*	
	Palm fronds	Coconut shell
pH H_2O (1:5)	6,22	6,41
C total (%)	53,22	71,37
N total (%)	0,94	0,96
C/N	56,62	74,34
P total (%)	0,04	0,17
P tersedia (%)	0,003	0,016
K total (%)	0,14	1,72
Ca total (%)	1,02	0,21
Mg total (%)	0,26	0,15
Na total (%)	0,03	0,22
KTK (meq/100g)	34,22	18,34
Kadar Air (%)	7,29	10,20
Kadar Abu (%)	29,36	13,24

Table 3. Properties and spectrographs of Biochar

Parameter	*Biochar Type*	
	Palm fronds	Palm fronds
Functional group type	Ether Aromatic Ring Carboxylic Acid	Phenol Aromatic Ring Carboxylic Acid Alkene
Surface area (m^2/g)	7,14	0,35
Volume(cc/g)	0,005	0,05
Pore size(mm)	$1,55 \times 10^{-9}$	$2,96 \times 10^{-7}$

Oil palm frond and coconut shell biochar were characterized using FT-IR. The characterization aims to observe the functional groups contained in the Biochar of oil palm fronds and coconut shells. The FT-IR results of palm frond and coconut shell biochar are presented in Figure 1 and Figure 2.

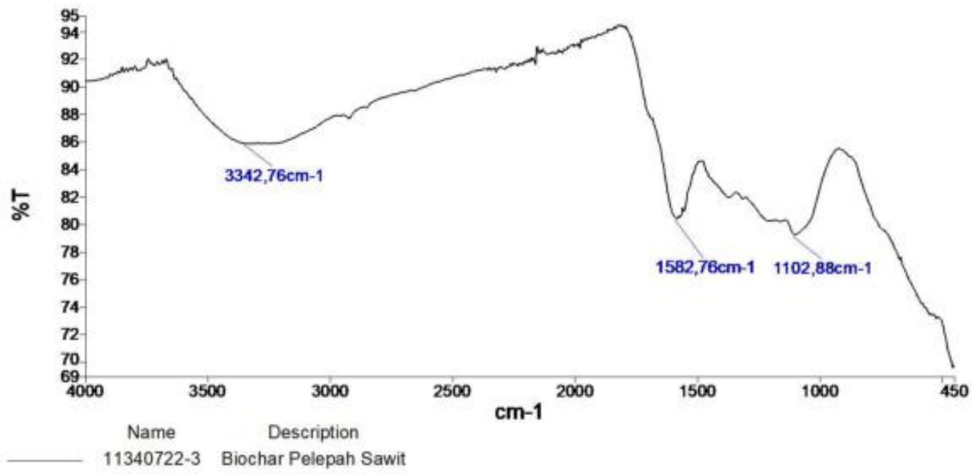

Figure 1. FT-IR spectra of palm fronds of Biochar

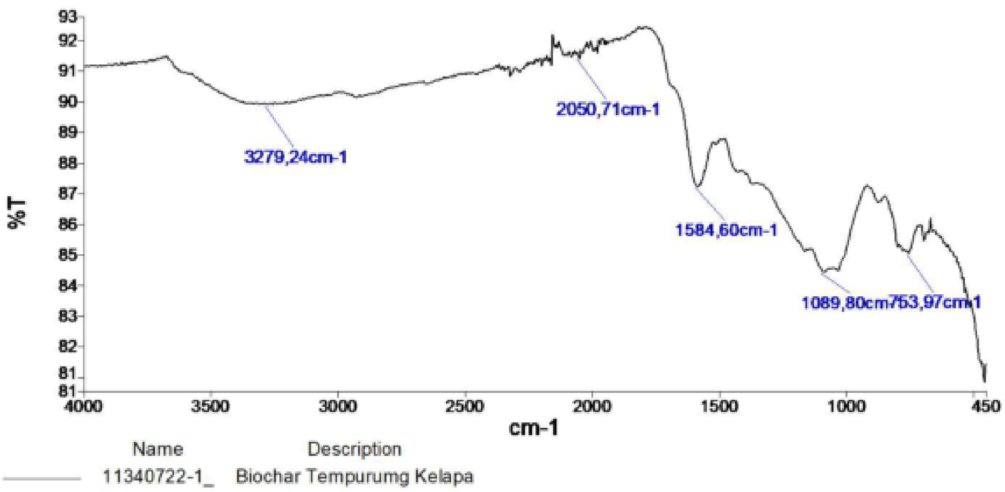

Figure 2. FT-IR spectra of coconut shell Biochar

Figure 1 shows that the Biochar of oil palm fronds was characterized using FT-IR. At wave number 1102.88 cm^{-1} is the ether functional group with strong intensity. At wave number 1582.76 cm^{-1} is an aromatic ring functional group with varying intensities. At wave number 3342.76 cm^{-1} is a medium-intensity carboxylic acid functional group.

Figure 2 shows that coconut shell Biochar was characterized using FT-IR. on wave number

753.97 cm-1 is an alkene functional group with a strong intensity. At wave number 1089.8 cm-1 is a carboxylic acid functional group with a strong intensity. At wave number 1584.60 cm^{-1} is an aromatic ring functional group with varying intensity. At wave number 3279.24 cm^{-1}, there are hydrogen bonding alcohol and phenol functional groups with varying intensities.

Soil's Water Content

The moisture content of peat soil after being treated with oil palm frond biochar and coconut shell biochar can be seen in Table 4.

Table 4. Soil's Water Content

Soil Fill Weight	Soil Fill Weight	Soil's Water Content (%)
Palm fronds (B1)	0 (D1)	51,78
	4 (D2)	52,59
	8 (D3)	35,76
	12 (D4)	53,03
Coconut shell (B2)	0 (D1)	53,27
	4 (D2)	55,12
	8 (D3)	57,88
	12 (D4)	59,72

Table 4 shows the water content of peat soil after planting ranging from 35.76 to 59.72%. The moisture content of peat soil before treatment is shown in Table 4.1, which was 47.86%. Peat soil water content in the treatment of coconut shell Biochar showed the highest water content value, and the increased dose of coconut shell Biochar also increased the soil water content after planting. In contrast to the administration of Biochar from the palm fronds at the treatment dose of 8 tons/ha showed the lowest soil water content value compared to other treatments.

This relates to the Biochar surface area depicted in Table 3, where the greater the Biochar surface area, the greater the soil water absorption. The study's results (Agviolita et al., 2021) indicate that research on the surface area of Biochar's pores can influence the results of water absorption in soil.

According to (Hanafiah, 2010), water is an essential component of soil that helps plants as a solvent and carrier of nutrient ions from the rhizosphere to plant roots, as well as a solvent and trigger of chemical reactions in the provision of nutrients, specifically from unavailable to high-sufficiency nutrients. available for plant roots and as a support for microbial activity in decomposing nutrients not previously available for plant roots. According to Endriani, A., and Sunarti (2013), Biochar's high water-holding capacity allows it to maintain soil moisture.

Soil Fill Weight

The bulk weight of peat soil after being treated with oil palm frond biochar and coconut shell biochar can be seen in Table 5.

Table 5. Soil Fill Weight

Soil Fill Weight	Soil Fill Weight	Soil Fill Weight (g/cm^3)
Palm fronds (B1)	0 (D1)	0,52
	4 (D2)	0,56
	8 (D3)	0,68
	12 (D4)	0,51
Coconut shell (B2)	0 (D1)	0,50
	4 (D2)	0,49
	8 (D3)	0,51
	12 (D4)	0,54

The bulk density of peat soil after planting ranged from 0.49 g/cm3 to 0.68 g/cm3, while the bulk density of the initial soil before planting was 0.69 g/cm3. Biochar derived from oil palm fronds had the highest BD value at a dose of 8 tons/ha compared to that derived from coconut shells and other doses. According to (Hardjowigeno, 2003), bulk density indicates the weight of dried soil per unit volume of soil, and its value can be used to assess the ability of plant roots to penetrate the soil layer. According to (Hartatik et al., 2004), soil with a high bulk density can withstand heavy plant burdens.

According to (Dariah et al., 2012), fibric (raw) peat in the lower layer has a BD of 0.1 g/cm3. In contrast, coastal peat and peat in river flow paths have a BD of >0.2 g/cm3 (Tie and Lin, 1991) due to the influence of mineral matter, but still far below the BD of mineral soils, which ranges from 0.7 to 1.4 g/cm^3. The study's results (Dariah et al., 2012) also demonstrate the magnitude of the influence of the maturation level of peat on the size of the BD of peat, with the average BD of peat increasing as the maturity level of peat increases.

4. CONCLUSION

Compared to oil palm frond biochar, the values of pH, total C, total N, C/N, total P, available P, total K, total Na, and the volume and pore size were higher for coconut shell biochar. However, the total Mg, Ca, CEC, and ash content and the surface area of oil palm frond biochar were higher than those of coconut shell biochar. The value of peat soil's moisture content and BD was greatest for coconut shell Biochar compared to oil palm frond Biochar.

REFERENCE

Agviolita, P., Ysuhadi dan F.K.A, A. (2021). Pengaruh perbedaan Biochar terhadap kemampuan menjaga retensi pada tanah. *Jurnal Fisika Unand (JFU)*, *10 (2)*, 267–273.

Balai Penelitian Tanah. (2015). Biochar Pembenah Tanah yang Potensial. In *Badan Penelitian dan Pengembangan Pertanian.*

Dariah, A., E. Matu'ah, dan M. (2012). Karakteristik Lahan Gambut. Panduan Pengelolaan Berkelanjutan Lahan Gambut Terdegradasi. *Balai Penelitian Tanah, Bogor.*

Endriani, A., dan Sunarti, S. (2013). Pemanfaatan biochar cangkang kelapa sawit sebagai soil amandement Ultisol sungai Bahar-Jambi. *Jurnal Penelitian Universitas Jambi Seri Sains*, *15 (1)*, 39–46.

Firmansyah, A. (n.d.). Biochar Sebagai Amelioran Tanah Marjinal Lahan Kering Dan Lahan Pasang Surut Untuk Peningkatan Produktivitas Tanaman Pangan Di Kalimantan Tengah. *Balai Pengkajian Teknologi Pertanian (BPTP) Kalimantan Tengah.*, *2010*.

Hanafiah, K. A. (2010). *Dasar Dasar Ilmu Tanah. PT Raja Grafindo Persada*.

Hardjowigeno, S. (2003). *Klasifikasi Tanah dan Pedogenesis.*

Hartatik, W., I. G. M. S. dan A. I. D. (2004). *Sifat fisik dan kimia tanah gambut*. Http://Balittanah.Litbang.Pertanian.Go.Id/Ind/Dokumentasi/Lainnya/Wiwik% 20 Hartatik.Pdf.

Mahmood, W. M. F. W., Ariffin, M. A., Harun, Z., Ishak, N. A. I. M., Ghani, J. A., & Rahman, M. N. A. (2015). Characterization and potential use of Biochar from gasified oil palm wastes. *Journal of Engineering Science and Technology*, *10*(Spec. Issue on 4th International Technical Conference (ITC) 2014), 45–54.

Mu'arif, S. (2021). *Pengaruh Pemberian Arang (Biochar) Pelepah Kelapa Sawit terhadap Perubahan Sifat Fisik Tanah Podsolik Merah Kuning (PMK).*

Tie, Y. L. and J. S. L. (1991). Characteristics and clasification of organic soils in Malaysia. *In Proceeding of International Symposium of Tropical Peatland.*, 107–113.