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Utilization of Carbide Waste Using Goat Manure Activator for Mine Soil Remediation

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Abstract

One way to improve the quality of wastewater and preserve the living environment is to use WWTP. WWTP is the final wastewater disposal and treatment facility. Pre-treatment, primary treatment, secondary treatment, and tertiary treatment are several stages of the wastewater treatment process. Wastewater treatment can reduce the levels of organic substances, nutrients, and harmful substances in wastewater, as demonstrated by liquid waste characterization values such as pH, TDS, TSS, BOD, and COD. As a result, WWTP can be used in a variety of industries. Wastewater management meets environmental standards set by government regulations. Wastewater treatment with WWTP can improve the quality of wastewater before discharging it into the environment and reduce waste pollution.

Keywords: Carbide, Remediation, Activator

1. Introduction

Mining is an up-and-coming sector for Indonesia that will increase financial and economic income. Indonesia's natural resources include mining, coal, and so on. Indonesia is also known as a country with very high mineral energy, by the regulation of the Minister of Energy and Mineral Resources of the Republic of Indonesia (ESDM) Number 26 of 2018 concerning the implementation of sound mining principles and supervision of mineral and coal mining. Based on Government Regulation No. 27 of 1980, minerals in Indonesia are divided into three groups A (strategic minerals, for example, petroleum, natural gas, iron ore, nickel, tin, and others). Group B (vital minerals, for example, copper, gold, iron, and so on). Group C (non-strategic non-vital minerals, for example, phosphate, gemstone, bentonite, sand, quartz, granite, limestone, etc.).

The composition of the excavated fill material of the former tin mine is divided into four major groups, as the upper excavation soil (topsoil), derived from the mixed soil of part A, horizon B and horizon C of the original soil; excavation soil from the lower part of the soil horizon C; tailings in the form of quartz sand, the residue of the washing process of tin ore separation processing and a mixture of tailings and lower excavation (Sukarman & Gani, 2017) and tailings are the part with the worst soil properties. In addition, there are dumping areas that come from marine clay, containing very acidic sulfate (pH 2.7-3.5) with macronutrients (N, P, K, Ca, Mg) not available to plants, so plants cannot grow. Those from kaolin parent material are white and impermeable, so water and plant roots cannot penetrate the layer (Asmarhansyah & Subardja, 2012).

Environmental principles that must be met in the implementation of remediation and post-mining according to Government Regulation No. 78/2010 on Remediation and Post-Mining in Article 4 Paragraph 1 are as follows: The principles of protection and management of the mining environment as referred to in Article 3 paragraph (1) letter a and paragraph (2) letter a, at least include 1. (2) letter a, at least includes 9 a) Protection of the quality of surface water, groundwater, seawater, and soil and air based on quality standards or standard criteria for environmental damage by the provisions of laws and regulations; b) Protection and restoration of biodiversity; c) Ensuring the stability and safety of overburden piles, tailings ponds, ex-mining land, and other artificial structures; d) Utilization of ex-mining land by its designation; e) Paying attention to local social and cultural values; and f) Protection of groundwater quantity by the provisions of laws and regulations. *Cellulolytic microorganisms* are microorganisms that produce cellulase enzymes (Rao, 2004). Some microorganisms such as bacteria, fungi, and others, can hydrolyze natural cellulose through cellulase activity (Delabona et al., 2012). According to Salina (2008), these microorganisms can degrade cellulose because they produce enzymes with different forms that work together. The enzyme will hydrolyze the (1,4)-ß-D-glucose bond in cellulose. Complete hydrolysis of cellulose will produce cellulose monomer glucose, and incomplete hydrolysis will produce disaccharides from cellulose called cellobiose.

2. Materials and Methods

2.1 Materials

The research location was PT LHOONG SETIA MINING, Aceh Besar Regency. Analysis of soil chemical properties was conducted at the Soil and Plant Research Laboratory, Faculty of Agriculture, Syiah Kuala University, Banda Aceh. This research will be conducted from March 2021 until completion. Materials used for soil analysis in the laboratory: Carbide waste used for remediation of mined soil; Goat manure (as an activator) for remediation of mined soil; GPS, soil drill, hoe, knife, plastic bag, camera, and other tools needed; Tools needed to analyze soil in the laboratory.

2.2 Methods

Ex-Mine Soil Sample Collection Sampling of ex-mining soil is done by taking ex-mining soil at the sampling location; the amount of sampling of iron ore ex-mining soil is taken as much as 1 (rice sack) weighing 20 kg. After sampling, they separated between stone and soil and sorted and obtained soil. Preparation of carbide waste. Carbide waste that has not been used anymore is taken as much as needed; carbide waste is needed for fertilizer additives because carbide waste has a composition that contains $CaCO3$ and also stores Growth Regulators (ZPT), which are needed by the soil that will be planted by plants (Vebriansyah, 2018). Goat Manure Preparation

Goat manure is required for this study, which is as much as needed. Goat manure is needed in this study because fungi are the main cellulase-producing microorganisms. There are sentences/phrases left behind because bacteria can also break glycoside bonds that can break β-(1,4) glycosidic bonds on cellulose compared to other microorganisms such as bacteria. Fungi that can produce cellulase enzymes are called cellulolytic fungi. These fungi are essential for composting organic waste. Some fungi that can produce cellulase are Trichoderma, Penicillium, Aspergillus, Gliocladium, Gonatobotryum, Syncephalastrum, and Paecilomyce (Salma, 2007). Experimentation of Carbide Waste and Goat Manure for Iron Ore Soil

The procedure carried out to determine the effect of carbide waste using goat manure activator to be applied to former iron ore mining soil on the variables of Fe, Al, soil Ph and N, P, C-Oragnik, and P-available in soil treatment as follows: 1 kg of ex-mining soil was taken for 6 test samples, Carbide waste 1 kg for 6 test samples, Goat manure 1 kg for 6 test samples, and Goat manure is used as an activator that will be needed by the carbide waste to accelerate the improvement of variable elements Fe, Al, pH, N, P, and organic C- in the former iron ore mining soil.

3. Results and Discussion

The results of this study consisted of iron ore soil analysis of biophysical characteristics of land, topography of the region, soil Ph, C-organic, N-total, P-available, Fe, and Al. Land biophysics. Iron ore mining in the Lhoong area, Aceh Besar district, uses an open-cast mining method. With a mining area of 500 H (Aceh ESDM 2020) and iron mining commodities, this mine obtained a business license in 2010 and ended its business license in 2025. Figure 1 shows the biophysical condition of the former open-cast mining area.

Figure 1 The biophysical condition of the former open-cast mining area.

The reddish color of the excavated soil (Figure 4.1) indicates the presence of old, weathered soil material excavated during mining activities. Poorly weathered minerals dominate this soil and have almost no remaining primary mineral content, such as loss of plant nutrient properties. The results of research by Shamshuddin et al. (1986) showed that the dominant minerals in the clay fraction on ex-mining land are kaolinite, mica, and chlorite, which indicates that the soil is classified as old soil; the result of this combination causes the soil around it to be no longer usable for agriculture. Figure 2 shows the condition of the former iron ore mining area.

Figure 2 shows the condition of the former iron ore mining area.

The difference in height and slope of the dominant slope determines the topography/shape of an area. The shape of the area in the former iron ore mining area in Lhoong District, Aceh Besar Regency is in the form of artificial land due to the ore mining process because there is excavation of excavated material. Based on the results of this research, the former iron ore mine land in Lhoong District, Aceh Besar Regency, has an area shape that varies significantly from flat and undulating shapes. The shape of the area in the location of the former iron ore mine has an irregular pattern, a rough and uneven surface, and in each form of area, there are still small holes also called voids. Also, if it rains, it will form a water-filled basin (Sukarman, 2016). Soil pH The laboratory soil analysis results show (Table 1) that soil pH at the research site / former iron ore mining site has increased in all soil sample treatments.

Table 1. Soil pH at the research site

Sample treatment	Soil pH
A (soil control)	4,29
B (soil + goat manure)	4,69
C (soil + carbide waste)	11,98
D (soil+carbide waste 70%+goat manure 30%)	7,92
E (soil + carbide waste 50% + goat manure 50%)	7,04
F (soil + carbide waste 30% + goat manure 70%)	7,86

Table 1 is directly proportional to the research conducted by Verbriansyah (2018), which says that the nature of this carbide waste content can improve the quality of soil pH, which has decreased due to mining activities. However, the results of the analysis using goat manure activator are not directly proportional to the results of Verbriansyah's (2018) research, which states that goat manure can also improve the quality of soil pH to neutral, although there is still an increase in soil pH, which is only 0.40. C-Organic (%)

The results of the C-Organic analysis in Table 2 show that the former iron ore mining soil (control) is 0.54. In the former iron ore mining soil, the highest C-Organic is found in the soil treatment added with 30% carbide waste + 70% goat manure) which is 1.43%, with the initial control result of 0.54. The highest C-organic in the second order is in the treatment of soil treatment added with 70% carbide waste + 30% goat manure, with the results of C-organic analysis is 1.16% with the initial results of soil control at 0.54. In the treatment of ex-mining soil added with 50% carbide waste + 50% goat manure with the analysis result of 0.78% with the initial result on soil control of 0.54.

Table 2: Results of C-organic Analysis of Former Iron Ore Mine Soil

Sample treatment	C-Organic (%)
A (soil control)	0,54
B (soil + goat manure)	0,93
C (soil + carbide waste)	0,62
D (soil+carbide waste 70%+goat manure 30%)	1,16
E (soil + carbide waste 50% + goat manure 50%)	0,78
F (soil + carbide waste 30% + goat manure 70%)	1,43

In treating soil added with goat manure, the result of C-Organic analysis is 0.93%. In the subsequent treatment, the soil added carbide waste with an analysis result of 0.62%, with the initial control soil result of 0.54. The results of the C-organic analysis of the soil + carbide waste treatment can only increase 0.08% of the control soil (initial ex-mining soil). This is thought to be caused by carbide waste, which contains a composition containing CaCO3 and also stores Growth Regulators (ZPT), which are needed by soil conditions for the soil to grow. Table 2 shows the results of the N-Total (%) analysis on the former iron ore mining soil above, showing the average increase from the control soil/soil without treatment. However, the increase is low. The highest % N-Total increase is in the treatments in D and F, namely, D soil added 70% carbide waste + 30% goat manure, and also in the treatment in F. Namely, soil added 30% carbide waste + 70% goat manure. Table 3. Results of N-Total Analysis (%) on Former Iron Ore Mine Soil Abel

Table 3. Results of N-Total Analysis (%) of Iron Ore Former Mine Soil

Sample treatment	N-Total (%)
A (soil control)	0,03
B (soil + goat manure)	0,07
C (soil + carbide waste)	0,03
D (soil+carbide waste 70%+goat manure 30%)	0,09
E (soil + carbide waste 50% + goat manure 50%)	0,04
F (soil + carbide waste 30% + goat manure 70%)	0,09

In the subsequent treatment, namely in E with the soil analysis results, 50% carbide waste + 50% goat manure was with an analysis result of 0.04%. In the analysis of soil added with carbide waste with an analysis result of 0.04% N-total with a control of 0.03, the increase in these results did not experience a high increase when compared to the control of former iron ore mining soil. This is because carbide does not impact the increase in N-total. Meanwhile, the provision of goat manure has increased but has yet to reach the same. This is directly proportional to Salma (2007), who said that fungi contained in the main cellulase-producing microorganisms some sentences/phrases are left behind bacteria can also break glycoside bonds that will be able to break β-(1,4) glycosidic bonds on cellulose compared to other groups of microorganisms such as bacteria. Fungi that can produce cellulase enzymes are called cellulolytic fungi. These fungi are essential for composting organic waste.P-available Table 4 below shows the results of the analysis of P-available in the former iron ore mining soil (control) with an analysis result of 5.30. The lowest P-available analysis results are in treatments C and D with soil analysis added carbide waste with analysis results of 0.20 mg kg-1. In the analysis for treatment D with soil added with 70% carbide waste + 30% goat manure with an analysis result of 0.20 mg kg-1 with the initial soil control of 5.30.

Table 4. Results of P-Total Analysis mg kg-1 in Iron Ore Mine Former Soil

Sample treatment	P- Available (mg kg^{-1})
A (soil control)	5,30
B (soil + goat manure)	4,30
C (soil + carbide waste)	0,20
D (soil+carbide waste 70%+goat manure 30%)	0,20
E (soil + carbide waste 50% + goat manure 50%)	0,80
F (soil + carbide waste 30% + goat manure 70%)	0,80

Table 4. Results of P-Total Analysis mg kg-1 on Former Iron Ore Mine Soil Abel In the following analysis, namely F with analysis in the form of soil added with 50% carbide waste + 50% goat manure with an analysis result of 0.80 mg kg-1 with the initial soil control result of 5.30. In the following analysis with the analysis of F in the form of soil added with 30% carbide waste + 70% goat manure, the analysis result was 0.80 mg kg-1. Then, the subsequent analysis of soil added goat manure with the analysis results of 4.30 mg kg-1. In Table 4, the results of P-available analysis in all treatments decreased. Carbide waste and goat manure can reduce P-available or can also increase P-available. This is because goat dung contains microbial bacteria Lactobacillus sp, fungi, and microbial groups (cellulolytic bacteria and fungi), which greatly help increase or decrease the P-available element of the former iron ore mining soil (Parnata, 2010). Fe (%) Table 5 below shows the results of Fe analysis on former iron ore mining soil in the initial control, which is 0.33%. The Fe analysis results in the treatment of soil added

with 30% carbide waste + 70% goat manure, with a result of 0.34. In the next analysis, the soil was added with 50% carbide waste + 50% goat manure, with a result of 0.34. Abel

Table 5. Results of Fe Analysis of Iron Ore Former Mine Soil

Sample treatment	**Fe (%)**
A (soil control)	0,33
B (soil + goat manure)	0,35
C (soil + carbide waste)	0,34
D (soil+carbide waste 70%+goat manure 30%)	0,34
E (soil + carbide waste 50% + goat manure 50%)	0,34
F (soil + carbide waste 30% + goat manure 70%)	0,34

analysis 0.34. In further analysis of soil added with 70% carbide waste + 30% goat manure with an analysis result of 0.34. The results of all analysis results in the three treatments with the same results of 0.34%. In the last analysis, the analysis of soil added goat manure with the analysis result of 0.35%. Table 5. Results of Fe Analysis on Former Iron Ore Mine Soil Abel

In Table 5. The results of Fe Analysis in Former Iron Ore Mine Soil show where the analysis results have increased from the initial control of the soil to after the treatment that has added carbide waste and goat manure. The above results show where these results experience an increase between 0.1 to 0.2. This is due to the factor of microorganisms that are less metabolized to reduce the Fe content in the soil; this is also due to the content of goat dung that causes microorganisms to fail to multiply due to shrinkage of the volume of the lower C / N ratio and temperatures ranging from 600-650C at the time of the final result (Tan, 1993). Al (%)

Table 6 shows the result of Al analysis on former iron ore mining soil, which is 0.14%. In all treatments, the results of Al analysis did not decrease, even tended to increase. In the treatment of soil analysis added to goat manure, the analysis result is 0.16. In the treatment of soil samples added with carbide waste, the analysis result was 0.17; in the treatment of soil samples added with 70% carbide waste + 30% goat manure with an analysis result of 0.17; in the treatment of soil added with 50% carbide waste + 50% goat manure with an analysis result of 0.16, and the treatment of soil added with 30% carbide waste + Kot. Goat manure is 70%, with a result of 0.20. Abel.

Table 6: Results of Al Analysis of Iron Ore Mine Waste Soil

Sample treatment	**Al (%)**
A (soil control)	0,14
B (soil + goat manure)	0,16
C (soil + carbide waste)	0,17
D (soil+carbide waste 70%+goat manure 30%)	0,15
E (soil + carbide waste 50% + goat manure 50%)	0,16
F (soil + carbide waste 30% + goat manure 70%)	0,20

Table 6 shows that the increase in Al content in the soil is due to the addition of goat manure material that can be used to overcome nutrient problems in the soil. In the decomposition process, organic matter (goat manure) will release organic acids that can increase Al and form complex compounds so that Al becomes undissolved. The application of goat manure is one of the improvement processes in soil content (Tan, 2010). Incubation is indicated so that the reaction of goat manure and ex-ore mine soil can proceed smoothly. Therefore, incubation treatment is essential to pay attention to so that later nutrients can be available. Jama (2000) states that incubation needs to be done to provide flexibility for microorganisms to develop and metabolize to reduce Al content in the soil. The thing that causes microorganisms to fail to multiply is due to the volume shrinkage of the lower C/N ratio and temperatures ranging from 600-650C at the time of the final result (Tan, 1999).

4. Conclusion

The conclusions that can be drawn from this research are using a mixture of carbide waste and goat manure with Al and Fe concentrations increased from the initial control; this was caused by microorganisms being less able to develop and metabolize to reduce the Al and Fe content in the soil. The use of carbide waste using goat manure activator can increase the Ph of Iron Ore Mine soil from the initial control of 4.29 to 7.04 by using a combination of 50% carbide waste and 50% goat manure. Using carbide waste and goat manure can increase soil nutrients, such as C-organic by 1.6%, soil N-Total by 0.09%, and soil P-available by 0.20 mg kg-1.

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