POTENTIAL OF COMMUNITY GOLD MINING AREA FOR SWEET SORGUM DEVELOPMENT AS RAW MATERIALS OF BIOETHANOL

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Abstract

The small scale gold mining might produces waste material derived from the mining and the amalgamation processes. This waste needs to be handled so as not to have a negative impact on the environment. Besides, the utilization of it would be hoped to give benefit for living, not to harm the life. Based on problems, this research was aimed to grow sweet sorghum on the contaminated soil and waste material as raw material for bioethanol production. Research was carried out by collecting soil samples and materials at mining or alteration sites (two soil samples), amalgamated solid waste (one solid material samples), soils affected by amalgamated wastewater stream (seven samples), and non-impacted soil as control. The results of this study indicated that sweet sorghum plants might grow well in the media in the form of waste materials, and contaminated soil gives relatively the same results as those in the rice field and uncontaminated garden soil. The juice that was produced from sweet sorghm stem had enough sugar content for bioethanol production using fermentation technique.

***Keywords**: soil, gold mining, sweet sorghum, bioethanol*

Introduction

The Community's gold mining land has an area that is not wide, but the mining process and land handling in general have not been pursued by minimizing negative impacts on the mine environment. The process of amalgamation to separate gold ore from the mined material is only carried out simply, and the worker safety rules have not been considered because they do not have sufficient knowledge. Management of liquid and solid waste from amalgamation has not been carried out and has the potential to contaminate the environment. Heavy metals content in waste can spread through surface water flow, so that it has the potential to contaminate soil, surface water, and ground water so that it can endanger human health (Mudgal et al., 2010). Post mine land in Marrakech, South Morocco, where rivers and soils were contaminated by copper (Cu) and zinc (Zn) from weathering of mineral minerals such as pyrotite, sphalerite, galena, chalcopyrite, arsenopyrite, pyrite and magnetite, and the pH of the river ranges from 2, 1-2,6, resulted the pH of river water was very acidic (El Khalil and El Hamani, 2008). Land use in the gold mining environment for food crop cultivation is at risk of being contaminated by heavy metals (Marino & Brica, 1997; Antonio, 2007). Contaminants consisting of heavy metals that are in the soil and water, and the flow of the river can be absorbed by plants.

Sweet sorghum is one of the biological resources that have great potential for industrial feed, especially in producing renewable energy (Zao et al., 2012), and as animal feed (Sirappa, 2003; Krismastuti, 2009). Sorghum has a wide adaptability to various environmental conditions and is a plant that is tolerant to drought and low fertility. In addition, another advantage of sorghum is that it does not require intensive land preparation and can be harvested as ratoon crop. This adaptation ability is an opportunity to develop a business of sorghum cultivation in marginal lands (dry land, acidic land, saline land, and idle land). Sorghum is able to grow and develop on post tin mining land with pH 4.0 or react acidically, poor in nutrients with very thin solum (Nurcholis et al., 2013). By applying ameliorant organic matter together, the remaining extracted tin ore has a good effect to increase solum thickness, nutrients and pH so that it affects the growth of sorghum plants.

Materials and methods

The research was carried out by collecting soil samples and parent materials at alteration sites (two soil samples), amalgamated solid waste (2 solid material samples), soil affected by amalgamation liquid waste (5 samples), and soil that was not affected by the mine as a control. Soil samples and waste material are dried air to be used for further research stages. For the study of sorghum planting using planting media, the soil and waste previously sifted through 4 mm filtered eyes, then weighed 15 kg and added 5 kg of organic and mixed fertilizer and NPK fertilizer 5 g. After mixing well, the media is put into a pot, and sorghum seeds are planted. The moisture of the planting media is maintained in conditions in the range of field capacity by adding water. The sweet sorghum plant that is grown is samurai-1 variety, as an irradiated product variety from Irradiation Application Center (PAIR) of National Nuclear Power Agency (BATAN) which had been released. Harvesting time of plants was done by utilizing maximum sugar levels in the sorghum stem. Based on preliminary research carried out previously, maximum sugar levels at 115 days old plants. Measurement of plant height, stem diameter, stem weight, number of leaves was carried out. Sugar levels were observed based on the Brix number of sorghum stem juice. The data is processed by calculating the standard deviation, and is presented in a graph of the average value of each parameter and the standard deviation value.

Results and Discussion

1. Environment of Community's gold mine

The Community's gold mine is generally carried out by stripping surface soil and digging up cover material or overburden (Figure 1a). After reaching the alteration zone the prospect ore to be collected as the materials processed are sorted. Materials that have the potential to be processed are collected and transported to the amalgamation site.

Figure 1. a. Area of community's gold mine, b. Amalgamation waste, c. Food crops on the dry land, d. Paddy soil and dry land

The amalgamation process leaves solid and liquid waste which has the potential to affect the environment (Figure 1b). Potentially contaminated land is in the form of dry land (Figure 1c), and wetland (Figure 1d). Problems of heavy metals contamination as well as other hazardous materials can arise due to the flow of the material through the ground surface flow (El Khalil, and El Hamani, 2008).

2. Sample characteristics

The samples collected and as a growing medium for planting sorghum are presented in Table 1. Samples of alteration sites from points 1 and 2 were sources of contamination derived from rock alteration processes that produce materials with gold content and heavy metals. The tailing sample was a residual material for the amalgamation process as a growing medium containing a source of contaminants. The soil collected from the location around the amalgamation process received contaminants from amalgamation waste exposed to the soil surface (samples number 6 to 10). Problems of contamination can arise if waste containing hazardous substances or compounds is exposed to the soil surface (Antonio et al., 2007; Galavi et al., 2010). The land that was not exposed to contaminants is the number 11, which is from the farmyard.

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Table 1. Soils, and other media for growing the sweet sorghum

No	Sample	Relation to contamination	Explanation
1	Alteration 1	Sources of conmaination	Located on the mining site, as the upper part of mountain
2	Alteration 2	Sources of contamination	Located on the beneath of mining site, as the upper part of mountain
3	Tailing	Source of contaminant from Hg treatment and heavy metals from alteration	Contaminant from Hg treatment resulted from amalgamation process, and heavy metals from alteration as solid residue containing heavy metals
4	Sawah 1	Suspected to contaminant	Heavy metals are transported by irrigation water as solution and suspended solid
5	Sawah 2	Suspected to contaminant	Heavy metals are transported by irrigation water as solution and suspended solid
6	Soil 1 (Warijan)	Contaminated soil	Soil on beneath the amalgamation process unit, that recieved liquid resdue of amalgamation
7	Soil 2 (Sunardi)	Contaminated soil	Soil on beneath the amalgamation process unit, that recieved liquid resdue of amalgamation
8	Soil 3 (Marsono)	Contaminated soil	Soil on beneath the amalgamation process unit, that recieved liquid resdue of amalgamation
9	Soil 4 (Parmo)	Contaminated soil	Soil on beneath the amalgamation process unit, that recieved liquid resdue of amalgamation
10	Soil 5 (Sumarjo)	Contaminated soil	Soil on beneath the amalgamation process unit, that recieved liquid resdue of amalgamation
11	Control (Atmo)	Non contaminated soil	Soil developed on the outside of mining area and it does not contaminated

3. **Production of the sweet sorghum crop**

Sorghum crop productivity of the present study was presented in the form of sorghum plant performance consisting of stem diameter, plant height, number of leaves, and wet weight of the stem. These parameters can be used as biomass productivity which is used as raw material for ethanol production and also animal feed raw material.

Figure 2 shows the results of measuring the diameter of sorghum planted in the planting medium in the form of alteration material with two samples showing normal growth of about 1.5 cm. For planting media in the form of lowland rice, the yield was quite good but has a high diversity, so that in paddy field 1 shows a high standard of error. For planting media in the form of tailings, the results of stem diameter were relatively the same as other media. Growing media from lands that were in the area for processing site or amalgamation environment (5 media samples) showed a good result. Planting media as a control in the form of soil that develops in a location that was not affected by alteration at the mine site and outside amalgamation gives good results on the size of the plant stem.

The height of sweet sorghum plant of Samurai 1 variety planted in the planting medium at the research location is presented in Figure 3. In general, the height of sweet sorghum plant of samurai 1 variety ranged from 150 to 250 cm. Parameters regarding the height of the sorghum plant are those who think it can relate the level of plant crunch. But the results of the data summary of many sorghum varieties do not show this (Bean & McCollum, 2006). What is interesting from the results of this study is that the highest plants among the planting media used for planting are tailings. Data on the diameter of the sorghum stem and sorghum plant height as a benchmark for the production of plant biomass. The potential of sweet sorghum as raw material in making sorghum is determined by the sorghum stem mass, and the stem mass is determined by the volume of sweet sorghum stems (Almodares & Hadi. 2009).

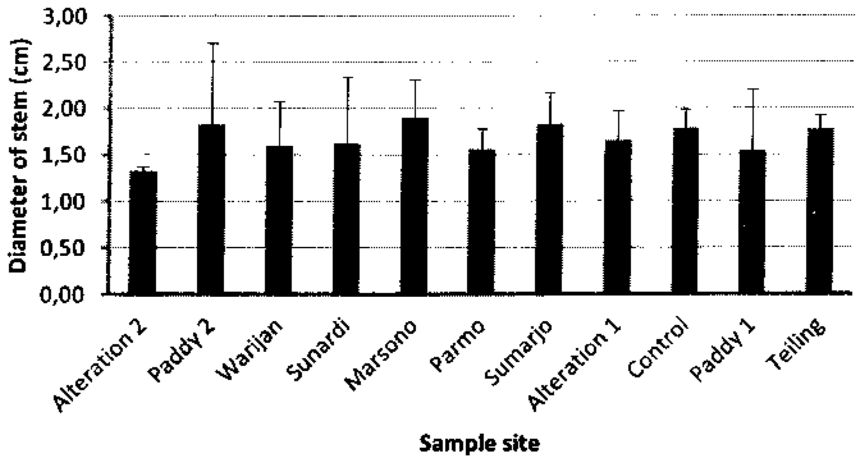

Figure 2. Diameter of sorghum stem

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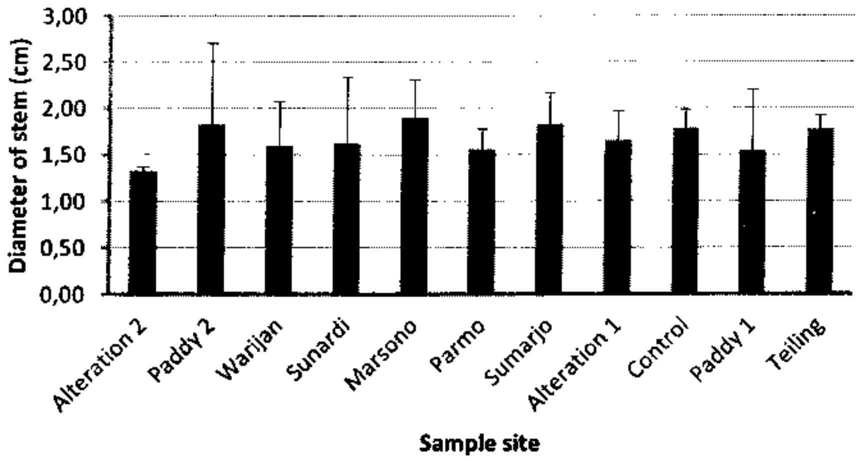

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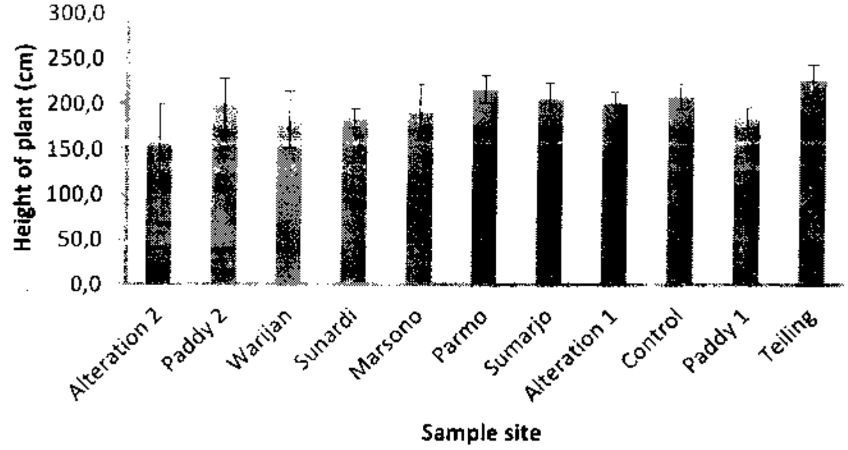

Figure 3. Height of sorghum plant

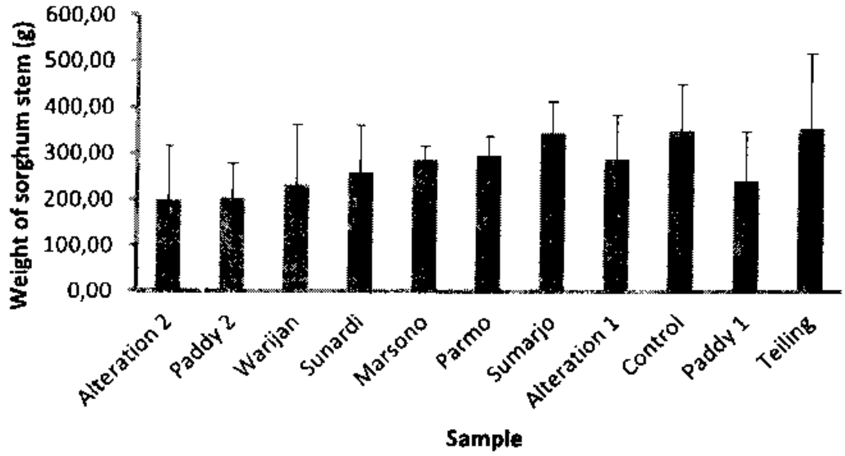

Figure 4. Fresh weight of sorghum stem

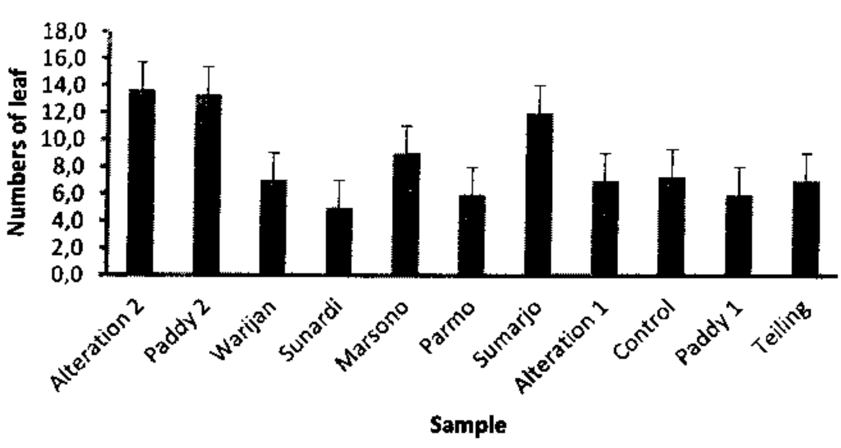

Figure 5. Amount of sorghum leaf

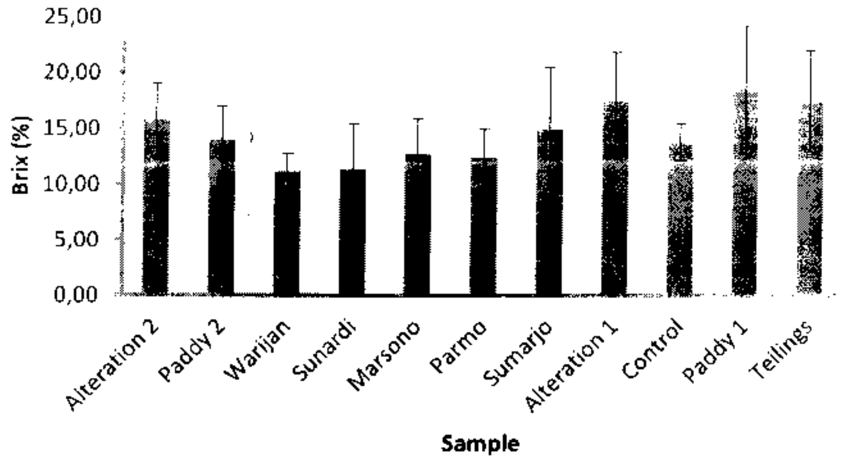

Figure 6. Brix number of juice of sorghum stem

The number of leaves in plants has a great meaning in terms of the function of sweet sorghum plants as animal feed. This is because when the sorghum stem is harvested the condition of the sorghum leaves is still green. High yields were obtained for the number of sweet sorghum leaves planted in the planting medium of alteration, paddy soil and contaminated soil in Sumarjo's place. In the case of animal feed producers, sorghum plants of various varieties from many countries have advantages over corn (Bean & McCollum, 2006).

Figure 6 shows the brix number of juice of the stems of sweet sorghum grown in various types of growing media in the community gold mine environment. In general, the brix number of the juice of sorghum stem planted in the soil around the low amalgamation process. However, for those planted in other lands, it shows a high brix number. Similar results were also obtained for the brix number of stem juice planted in the medium in the form of tailings. Brix number has proximity to sugar levels, because this value is obtained from the refraction of crystals in the juice, and most of the crystals in the juice are types of sugar. So that with a large brix number, the part that can be converted into ethanol to be bigger. Sorghum stem juice contains various types of sugar, the main ones being glucose, sucrose and fructose, while other types of maltose, dextrin, maltotriose and oligosaccharides also exist in low concentrations (Massoud & Razek, 2011). The value of the brix number from the juice of the sweet sorghum stem which shows the sugar content is very important in relation to bioethanol production. For good fermentation the optimum sugar content is needed. Juice which has sugar content of 161.50 g/L or 16.150% can be fermented using *Saccharomyces cerevisiae* yeast into 80.56 g/L ethanol or 8.056% (Nasidi et al., 2013). The results obtained from this study indicate that sorghum stem juice from planting in alteration 2. Rice fields 2 and tailings have a sugar content that can be processed into ethanol.

Figure 7. Performence of sorghum crop at mature stage on all used growing media

4. performance of sorgum crop

Sorghum plants that were grown in all types of media did not show different performance (Figure 7). The growth of all plants that was shown by plant height and leaf color did not show any morphological disturbances. Sorghum plants have the ability to adapt to soil conditions that are very nutrient-poor, coarse-textured, primary minerals dominated by quartz, and high soil acidity (Nurcholis et al., 2013). Even under conditions of salt, even though some sorghum cultivars that have a high K/Na ratio in the stem and root and high storage factor index (SFI) properties can make partitions between roots and stems. The result is that these cultivar plants can grow and produce on soil with high acidity (Shakeri & Emam. 2017).

Conclusions

The community's gold mining environment produces waste material originating from the mining process and the amalgamation process. Waste from the mining process in the form of a mixture of coarse material, i.e. rock fragments resulting from weathering, and also fine fractions such as soil. The waste from the amalgamation process is in the form of fine fractions after fragments of mining and material selection that prospects are cuminated and the screening process in amalgamation tubes. Sweet sorghum plants grown in the media in the forms of waste material, and waste contaminated soil provide relatively similar results to those in uncontaminated rice fields and garden soil. The difference in results of stem diameter, plant height, number of leaves, stem wet weight and number of brix did not provide a pattern for deciding the best type of planting media from the sample used.

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