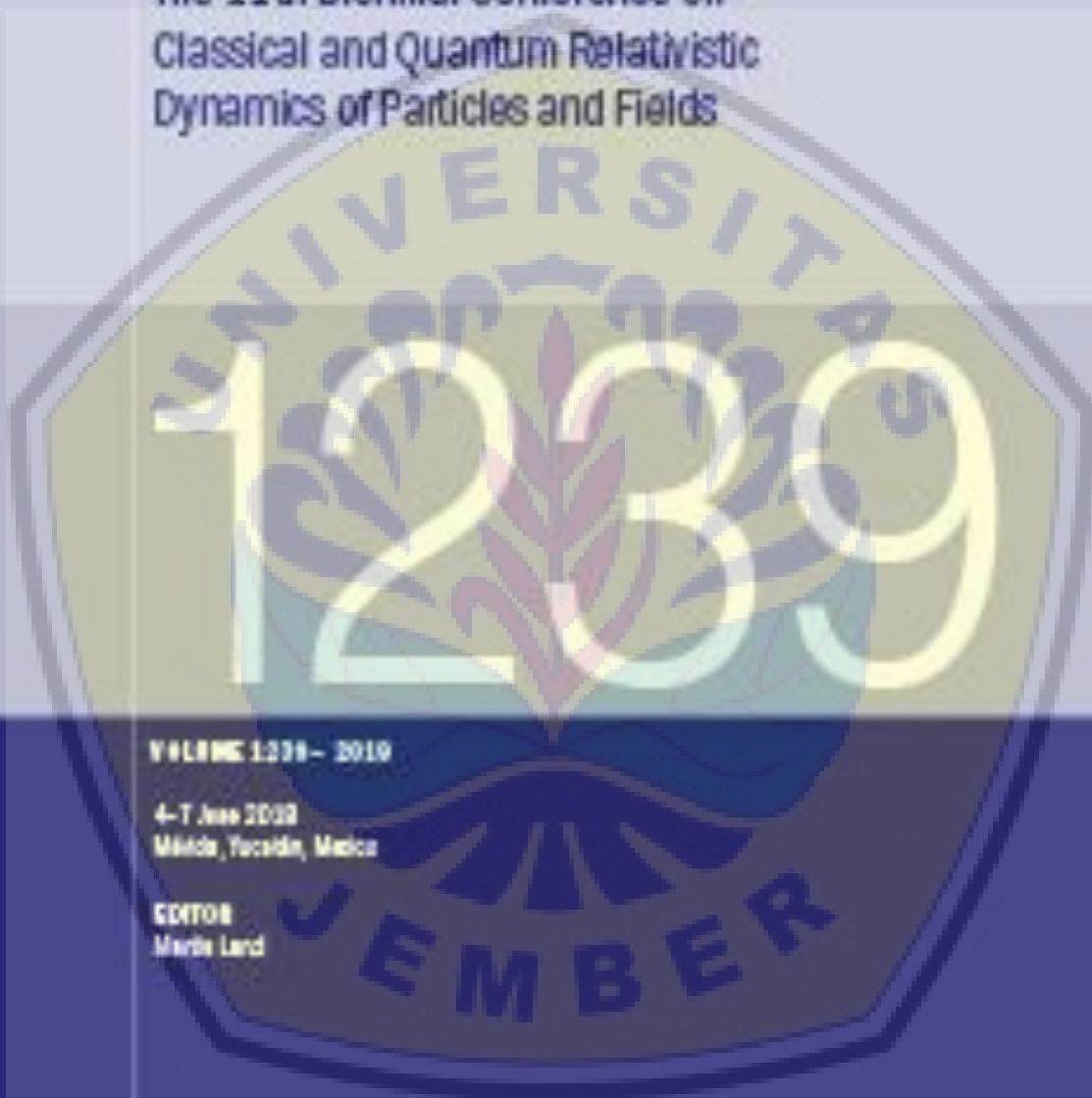


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The formulation Robusta coffee bark Jember Indonesia for charcoal Briquettes as alternative energy : The comparison organic starch adhesive and anorganic adhesive

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Abstract. The Robusta coffee plantation were founded from Silo Jember district Indonesia. One of the solid waste coffee plantation is coffee bark. The objective of this study is to find the formulation of Robusta coffee bark Jember for charcoal briquette as alternative energy. The formulation of charcoal robusta coffee bark were comparisson within organic starch adhesive and anorganic adhesive. The formulation were analyzed in physical and chemical quality base on SNI Number. 01-6235-2000. the solid waste coffee plantation were collected from smallholders coffee plantation on Silo Jember. The first step were drying the solid waste coffee bark in the sun almost 2 days till dried. Then, the dried coffee bark were using pod waste pyrolysis in reactor with a temperature of 400 C until became charcoal. Organic starch adhesive were making by mixing the the 6 gram starch and 60 milliliter water (ratio 1:10), and then mixing down with 60 gram charcoa (formula 1). Formula 2 were mixing the 60 gram charcoal, organic starch adhesive and added 3 gram anorganic adhesive. The briquettes were formed into tube with diameter 6 cm and the thickness 4 cm. The result showed that using organic starch adhesive were more fragile, harder to light the fire first but dried faster than using anorganic adhesive. The chemical analysis on the formula 1 (briquette with organic starch adhesive) and formula 2 (briquette with anorganic adhesive) showed that moisture were 9,87% ; 7,7 %, volatil matter were 5,87%; 4,2 %, the Ash content were 8,01 % ; 5,03 %, the caloric value were 4870 cal/gr; 7233 cal/ gr and the fixed carbon were 65%; 81%. The formula 2 showed the better quality than formula 1.

1. Introduction

The area of coffee plantation in Indonesia in 2017 is 1,227,767 hectares. Robusta coffee is the most widely coffee cultivation in Indonesia. The area of robusta coffee planting in East Java in 2012 are 85.132 Hectar. Jember, East Java Indonesia is one of the area that producing Robusta coffee. The productivity Robusta coffee in Jember reach 904 kg/ Hectare [1].



The activity of coffee plantation produces solid waste such as coffee bark. The Robusta coffee area in Jember reaches approximately 5.524.01 Ha. That's about 95% of the area & coffee production in Indonesia is the smallholder's coffee. The one hectare coffee plantation capable of producing 1.8 tons coffee bark, then the waste generated from coffee plantations in Jember is 9.943 tons of coffee bark waste. One of the coffee producing regions in Jember district is Harjomulyo village, Silo district.

The most people of Harjomulyo village had work as labour farmer and planting coffee around their field. Coffee bark are the solid waste that produced besides harvesting the coffee. Coffee bark became the main problem, because of they didn't utilized and the amount increase every time. People just throw away on their field and burn it. Robusta coffee ground can be used to adsorb the lead (Pb) pollution in the water [2], so the utilization of coffee bark should be analysis to give the economic value for coffee farmer. Briquette biomass have many advantages such as reduce greenhouse gases, adding income for farmers, creating job for women, enhance sustainable development [3].

The solid waste of coffee plantation had the potential to use as the renewable energy like briquette. Coffee bark had high calorific value, low water content, and low sulfur content [4]. The utilization of coffee bark to briquette will give the solution for environment, scarcity of fossil fuels and give the economic value.

The energy crisis are the global problems in the world. All country competing solve that problem to find the source of renewable energy. Indonesia is the third largest country produced coffee and also produce the third largest coffee bark too. Indonesia had potential to produce renewable energy briquette from coffee bark. Briquette is biomass material such as charcoal for fuel and kindling to start a fire.

Produce the briquette from coffee bark had many challenge. It is need the good ratio material and adhesive to get good quality of charcoal coffee bark briquette. Organic material, like coffee bark often had fragile, lower heat than fossil fuel. This research conducted to find the right formulation Robusta coffee bark briquette as an alternative energy and compare the physic and chemical quality of the briquette with organic starch adhesive and anorganic adhesive.

2. Methodology

Materials. The Robusta coffee bark have been collected on smallholder coffee plantation Silo- Jember District- Indonesia.

The briquette making procedures:

Drying. The solid waste coffee plantation were drying on the sun almost 2 days till dried.

Making Charcoal Briquette. The dried coffee bark were using pod waste pyrolysis in reactor with a temperature of 400 C until became charcoal. It marked by the cessation of liquid smoke from the smoke outlet.

Shifting. The charcoal were shifting to get the same partikel 100 mesh.

Organic starch adhesive were making by mixing the the 6 gram starch and 60 mililitre water (ratio 1:10), heat the water and stirring continued til ticken, and anorganic adhesive using wooden white adhesive.

The Formula:

Formula 1: mixing the 60 gr charcoal coffee skin and 6 gram starch adhesive. The ratio were 10:1.

Formula 2: mixing the 60 gr charcoal coffee skin, 6 gram starch adhesive and 3 gr anorganic adhesive.

The ratio were 20:2:1

The form. Briquettes were formed into cylinder with the average outside diameter 6 cm, the average inside diameter were 1,5 cm and the thickness were 4cm. The briquettes were dried in the sun till dried.

This research want to compare the Robusta coffee bark charcoal briquettes with organic starch adhesive and anorganic adhesive. The quality of briquettes were analysed in physical and chemical characteristic.

3. Result and Discussion

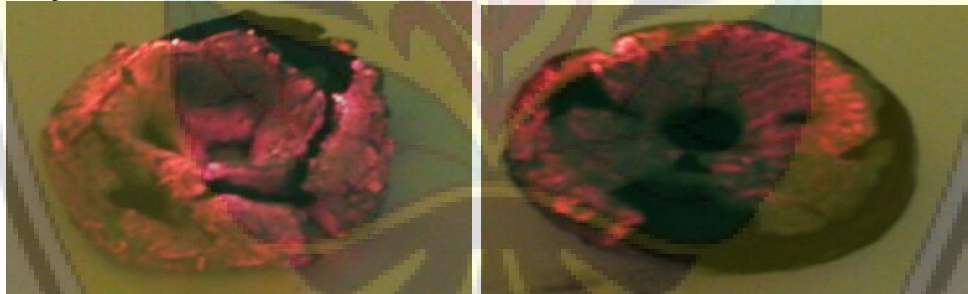
Renewable energy needs to be attempted to suppress the dependence on fossil energy. Pakistan Academy Science also prepare about that [5] Many materials can be source for renewable energy. they are such as water hyacinth [6], rice straw and sugar cane leaves [7], sugar palm (*Arenga pinnata*) [8],

palm oil empty fruit bunches [9], tannery solid wastes (TSWs) such as comprise hair, flesh, chrome shavings and buffing dust [10]. Coffee bark were solid waste. Coffee bark have the potential to use the renewable energy like briquette [11]. This research will be compare the quality of charcoal briquettes from Robusta coffee bark from Jember Indonesia, with organic starch adhesive and anorganic adhesive. The quality of briquettes must be analysed in the many parameters before applied. The physical and chemical parameters were analysis in this research. The physical parameter were analysis in fragility, drying time, ignition first, and the speed to ash. The chemical parameters were analysis in the water content (moisture), volatile matter, ash content, caloric value and fixed carbon.

1. The Physical Characteristic

The visual inspection of physic characteristic showed that the formulate 1 were more fragile than formulate 2. The physic characteristic of briquette can confirm by visual inspection and impact test, without Appling amount of pressure [12]. The briquettes formulate 1 were faster dry than formulate 2. It probably cause of in the formula 2 added the wooden adhesive as an organic adhesive. Wooden adhesive often contain the polyurethane which hold the water, so formula 2 need more time to dried in the sun. Briquettes formula 1 showed that more difficult to ignition first than briquettes formula 2. Briquettes formula 1 also faster to ash than briquettes formula 2. Adding the wooden adhesive make the briquettes not breakable and not quickly to ashes. The choosing material and proportion adhesive affected the quality of briquettes (Figure.1,2).

The good quality of briquette will determined by the right proportional material and adhesive. We should find the right material and composition to produce the good briquette. Some research showed that molasses, clay and carbonized bagasse (1:1:40) can produced the best physical characteristic such without sparks and smokeless than other material ratio proportion [13]. Not only the main material, The choosing adhesive and their proportion were important to produce the good quality of briquettes. the the optimum composition of the material with the adhesive were 50% [14].



Source: Author

Figure 1. Formulate 1

Figure 2. Formulate 2



Source: Author

Figure 3. The formulate 1 faster become ashes than formulate 2

2. The Chemical Characteristic

The Water content (Moisture). Water content is the one of the important parameter to determine the quality of briquettes. This result show that the moisture of briquettes formula 1 and 2 were 9,87 % and 7,7%. Added the anorganic adhesive decreased the moisture till reach ≤ 8 %. Where meet the requirements of the briquettes quality standard's Indonesia number 1/6235/2000. The water content related with the ignition first. The higher water content in briquettes, make harder the ignition first than less water content. The least water content in the briquettes, make the briquettes better in the quality because of caloric value has increased [15]. However, there were not any problems if we storage the briquettes in height humidity during period [16].

Volatile matter (Vm). Volatile matter are the flammable gases. Volatile matter should be measure to know the quality of briquettes. This result showed that volatile matter formula 1 and 2 were 5,87% and 4,2% (Indonesian standard quality of briquettes). The higher the Vm level, the briquette will burn faster and the burn rate becomes faster. Ash Content. The good quality of briquette has a low ash content. The high ash content degrade the quality of briquettes. The high ash content in the briquette accelerates the formation of the crust. The ignition of briquettes will be more difficult if the ash content is high. The ash content briquettes formula 1 and 2 were 8,01 and 5,03. The observation showed that formula 1 were harder ignition for the first than formula 2.

Calorific value. Caloric value is the amount of heat generated by the complete combustion of a material. A briquette will have a good quality if it has a high heating value. The calorific value of briquette skin of formula 1 was 4876 cal /gr while the calorific value in formula 2, were 7233 cal /gr. The Robusta coffee bark from Jember, Indonesia had the high calorific value, so they had potential as material to produce briquettes. In nature, we could find the organic material that had potential to use as material for renewable energy. the elephant grass had calorific value of 14.66 MJ/kg and the spear grass have 15.12 MJ/ Kg respectively [15].

Fixed Carbon. The fixed carbon in the formula 2 were higher than formula 1. The fixed carbon value, contribute the calorific value. When the fixed carbon high, it was followed by the increase the calorific value. The fixed carbon decrease the ash contain and volatile matter. The height value of fixed carbon showed the higher quality of briquettes. The comparison of chemical characteristic robusta coffee bark Jember Indonesia as charcoal briquettes with organic starch adhesive and anorganic adhesive completely see in the Table 1.

Table 1. The chemical characteristic Robusta Coffee bark Indonesia with organic starch adhesive and anorganic adhesive

No	Parameter	Organic Adhesif (formula 1)	Adding anorganic Adhesive (formula 2)	Indonesian standart	Japan Standart	USA Standart	England standart
1.	Moisture (%)	9,87	7,7	≤ 8	$\leq 6-8$	6	3-4
2.	Voaltile Matter(%)	5,87	42	≤ 15	15-30	19-28	16,4
3.	Ash Content(%)	8,01	5,03	≤ 8	5-7	16	8-10
4.	Callorific Value(%)	4876	7233	≥ 5000	5000-6000	4000-6500	5870
5.	Fixed Carbon(%)	65	81	≥ 77	60-80	60	75

Source : Author

Briquettes are the renewable energy alternative. The solid waste of organic matter often can reuse as the main material of briquettes, such as the Robusta coffee bark from Jember Indonesia. Briquettes as

alternative energy, had challenge to prove that their application are easy, able as source energy, and save for the health and environment. The result showed that Robusta coffee bark from Jember can use alternative energy as briquette. The chemical analysis showed that moisture, volatile matter, ash content, calorific value and fixed carbon were meet the Indonesian standard quality of briquettes. The research showed that the briquettes with anorganic adhesive (formula 2) were better quality than organic starch adhesive both in physical and chemical analysis. There were many factors to relate on quality of briquettes. The briquettes were relate on material variable and process factors [17]. Before selected the material of briquettes, it better should know the energy level of biomass and find the right ratio for good quality of briquettes [18]. The ratio of briquettes material were important too. Briquettes from coffee residue and fat dregs with ratio 50:50, showed that the highest caloric value than other variation such fat dregs residue and tea residue, and also tea residue and coffee residue [19].

The other research showed that mixing waste paper and coffee residues had good in calorific value, water content, ash content [20]. The paper briquettes was the highest caloric value comparing the rice husk and coconut coir briquettes [21]. The treatment of the main material briquette give effect to the quality of briquettes. The roasting material may increase the calorific value and the resistance to biodegradable but decrease the volatile matter value [22]. The proportion of adhesive contribute the quality of briquettes. Some research on briquettes sesame stalk showed that increasing number of clay were decrease the calorific value [23]. Adding the anorganic adhesive make the Robusta coffee bark charcoal briquettes had better in physical and chemical quality. But the principal of alternative energy are save for environment and health. Anorganic adhesive contain some chemical substance that may affected for health. Wooden white adhesive usually contain Poli vinyl acetat (PVAc). Vinyl acetad had effect on our health. In the animal laboratory, Exposure the Vinyl acetate amount 1,000 ppm in the air for weeks can cause irritate eyes, nose, throat and lung of laboratory animal [24].

Although using the anorganic adhesive can improve the quality of briquettes, but it still have risk for the health. Further research must be find the organic adhesive which the most suitable for Robusta coffee bark briquettes in material and ratio to produce the best quality in Robusta coffee bark briquettes.

4. Conclusion

Robusta coffee bark Jember, Indonesia had potential to use the alternative energy like briquettes. The charcoal briquette from robusta coffee bark showed the good quality in both physical and chemical characteristic. The formulate 2 which added anorganic adhesive had better quality than formulate 1 which added organic starch adhesive.

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