Charchoal briquette production from coconut (*Coconut nucifera*) waste to provide alternative energy

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Abstract

Keywords: *carbonation, harcoal briquettes, coconut waste, feaseble (maximum 5 words)*

Coconut waste in the form of leaf stalks, coat and fruit bunches is still not utilized, which often causes soil, water and air pollution. This research aimed to determine the extent of the technical feasibility of the waste carbonization process and the financial feasibility of charcoal briquette production. The carbonization process of coconut waste was carried out using pyrolysis so that product formation ran more perfectly. Design and feasibility analysis of a pilot unit for processing coconut waste on a scale of 5 tons per day, which produced charcoal briquettes as the main product and liquid smoke and tar as by-products. Charcoal briquettes were made by mixing coconut waste charcoal dust and tapioca binder in portions of 5%. The charcoal briquettes produced were in accordance with Indonesian and international quality standards, including: water content, ash content, firmness, fixed carbon content, and calorific value. The pilot production unit for processing charcoal briquettes apparently obtained an NVP of IDR 2,509,011,381 and a B/C ratio of 1.582 at an interest rate of 10%. In addition, the product volume BEP was achieved at 177,196 tonnes and the BEP value for money was IDR 888,979,900. Thus, the production unit for processing charcoal briquettes from coconut waste was technically and financially feasible.

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1. Introduction

Coconut waste comes from fruit, bunches and leaf stalks which are usually thrown away or burned openly. Open burning and dumping of waste results in poor sanitation, blockages of waterways and release of various air pollutants, including particulates and carbon monoxide [1;2]. The process of decomposition or accumulation of biomass waste will cause soil, water and air pollution, and even produce carbon dioxide and methane gas which play a role in accelerating global warming [3].

On the other hand, the world community must immediately gradually reduce fossil fuels, and instead need to be encouraged to use biomass fuels which are renewable and environmentally friendly because they are carbon neutral [4]. Charcoal briquettes can be made from various materials, for example rice husks, wood, sawdust, corn cobs, fruit shells, and coconut shells. Likewise, the binder used can be: starch, tapioca, molasses, tar, sap, young plant leaves and so on [5] .

This research aimed to convert coconut solid waste biomass into charcoal briquettes as an effort to provide new, renewable and environmentally friendly energy. Meanwhile, the target of this research was to determine the technical and financial feasibility of the business of producing charcoal briquettes from coconut waste. If this innovation was successful, two benefits could be obtained, namely: (i) waste biomass could be reduced through the circular economy charcoal briquette production process; and (ii) environmental sanitation of coconut plantations and processing industries in a sustainable manner..

2. Materials and method

2.1. Materials

Preparation of source younger coconut coat waste turned into received from five exclusive sites (10 kg each) representing its sheller in Tasikmalaya city. The waste changed into crushed to a length of approximately (5 x 5) cm, mixed homogeneously, after which dried inside the sun until it reached a moisture content of 20%, which served as the feedstock for the pyrolysis method in the oven.

2.2. Method

The production of charcoal and liquid smoke from young coconut peel adapted to the procedure of Rahmat *et al*.'s procedures [6]. The feedstock was placed in a furnace made of steel tubes with a diameter and height of 23 and 32 cm, respectively, as a pyrolysis chamber. The young coconut peel as the starting material were heated to 450 °C for 90 minutes.

Briquettes are produced using the Febrina process [7], which begins with the pyrolysis process and then continues with the grinding and screening of the charcoal. The charcoal powder is mixed with 10% starch glue to obtain a homogeneous mixture, which can then be pressed. The mixture was formed into briquettes using a manual hydraulic press. The molded briquettes were then dried in the sun for two days. Carracterization of coconut waste charcoal briquett was accorded to ASTM D5142-02 [8].

3. Results and Discussion

3.1. Carracterization of charcoal briquetts of young coconut waste

Table 1. Characteristics of charcoal briquettes based on test results.

		Standard

Parameters test	Value on Sample Briquette	Indonesian	Japanese
Water content (%)	7.79	8	6 - 8
Volatile content (%)	26.74	15	15 30
Ash content (%)	2.76	8	3 - 6
Fixed carbon (%)	68.66	77	60 - 80
Density (g/cm^3)	0.62	-	1.0 – 1.2
Compression force (kg/cm^2)	32.44	-	60 - 65
Calorific value (cal/g)	6.211	5,000	6,000 – 7,000

The water content in charcoal briquettes affects its calorific value, namely the higher the water content, the lower the calorific value. Charcoal briquettes are hygroscopic, so their water content can be used as a basis for evaluating their storage. The water content of the sample charcoal briquettes in this test was lower than the standard water content in Indonesia of 8% [7]. This proves that, from the aspect of water content, the charcoal briquettes meet the requirements. The high or low moisture content of charcoal briquettes is determined by the type of material the biomass comes from, for example albazia wood has a lower specific gravity than ironwood and its hygroscopic properties are stronger so the charcoal briquettes have a higher moisture content [9].

The content of volatile components in the test briquettes was higher than within the Indonesian and Japanese requirements. This suggests that coconut waste charcoal briquettes do now not meet the requirements. The better volatile content material produces extra smoke at the same time as the briquettes are burning. The smoke is produced by using way of the response of carbon monoxide (CO) with alcohol derivatives [10].

The ash content material of the take a look at sample briquettes changed into 2.76%, that's under the Indonesian widespread but within the sort of the Japanese favored. For that reason, the charcoal briquettes were appropriate as a capability substitute fuel. Too high ash content material can lessen the calorific velue of charcoal briquettes, just so the wonderful of charcoal briquettes decreases [11].

The consequences of the fix carbon content material check of the coconut waste charcoal briquettes showed of 68.66 %, which changed into decrease than the Indonesian standard and inside the form of the Japanese preferred, which became consistent with the awesome of the gas. The fixed carbon content material is stimulated thru the specific gravity of the raw material, the charring technique, and unstable components. A excessive density of the raw material effects in a excessive fixed carbon content. However, a low unstable content material will growth the solid carbon content [9].

Coconut waste charcoal briquettes had a density of 0.62 g/cm^3, which become despite the fact that under the Japanese standard. It became counseled that there were nevertheless many empty areas within the charcoal briquettes, which become due to the uneven particle duration and inadequate compaction. Previous research confirmed that charcoal briquettes crafted from coconut waste had the density of 0.86 g/cm^3, at the equal time as charcoal briquettes made from madan wood had the density of 0.68 g/cm^3. From this study, it could be concluded that most of the density is stimulated through the particular gravity of the substance itself.

The compressive force of briquettes is the capacity of the briquettes to resist fracture or crushing at the same time as a load is executed to the object. The higher the compressive stress of the charcoal briquettes, the higher the resistance of the briquettes to crushing [12]. The compressive pressure of the coconut peel charcoal briquettes turned into 32.44 kg/cm^2, which became, but, decrease than the japanese modern day. This confirmed that the composition and approach of compression not met the requirements. This improvement in the terrific of compression power will be very critical for the sturdiness of the briquettes inside the package and clean transportation.

The calorific value of the charcoal briquettes from the take a look at turned into 6,211 cal/g, that is inside the form of Japan standard and better than the Indonesian standard [7]. The heating value of the charcoal briquettes became better than that of the Nipah fruit-jacketed charcoal briquettes, which turned into 5438.80 cal/g. Consequently, those charcoal briquettes met the requirements primarily based on their heating rate [9].

3.3. Simulation of the feasibility of producing charcoal briquettes from coconut waste

This simulation assumed the production of charcoal briquettes from 5 tons of coconut waste per day. Analysis of the financial feasibility of charcoal briquette production consists of investment capital estimates, production cost estimates, break even point calculations, income estimates, determining investment criteria, namely Net Present Value, and B/C Ratio.

3.3.1. Financial transaction

Investment costs are fixed costs whose amount is not influenced by the number of products produced. The investment required to realize a charcoal briquette project or business was IDR 350,000,000 consists of procurement of machines, procurement of tools and buildings. More clearly can be seen in Table 2.

Operational costs consist of fixed costs and variable costs. Fixed costs for one year of the production process amounting to IDR 41,800,000 incurred for depreciation costs and machine and building maintenance costs. Furthermore, variable costs amounting to IDR 1,004,000,000 were spent on procurement of coconut biomass, procurement of binder (5-7%), labor wages, electricity and local transportation.

Revenue from the production of charcoal briquettes in one year of the production process at a selling price of IDR 5,000.00 per kg was IDR 1,800,000,000.00. The income or profit obtained was IDR 796,000,000.

Table 2. Transaction simulation on the production capacity of charcoal briquettes from 5 tons of coconut waste per day

	Type of Transaction	Details (IDR)	Total (IDR)
A.	Investations		
	1. Machinery procurement	250,000,000	
	2. Tools and buildings procurement	100,000,000	
	Total		350,000,000
B.	Fixed costs per year		
	1. Depreciation expense	6,800,000	
	2. Machinery and building maintenance costs	35,000,000	
	Total		41,800,000
C.	Variable costs per year		

	1. Procurement of coconut biomass: 5 tons x 20 days x 12 months x IDR 200,000	240,000,000	
	2. P Procurement of binder 100 kg x 20 days x 12 months x IDR 10,000	240,000,000	
	3. Wages : 8 people x 20 days x 12 months x IDR 200,000	384,000,000	
	4. Electricity (B2) at 50 kVA: 30,000 VA x 10 hours x 20 days x12 months x IDR 1,444.7	104,000,000	
	5. Local transportation: 12 months x IDR 3,000,000	36,000,000	
	Total		1,004,000,000
D.	Revenue per year Charcoal Briquettes (Key product): 1.5 tonnes x20 days x 12 months xRp 5,000,000	1,800,000,000	
	Total		1,800,000,000
E.	Profit per year (E = D - C)		796,000,000

3.3.2. Analysis of NPV and B/C ratio

The results of the feasibility analysis for producing charcoal from coconut waste based on determining the NPV (net present value) and B/C ratio values at different interest rates, namely 10, 15 and 20 percent, turned out to be positive NPV values and B/C ratios with a value of more than one. This shows that the charcoal production business is feasible to run.

Table 3. Results of determining NPV and B/C-ratio at three levels of interest rates

Interest rate (%)	NPV (IDR)	B/C Ratio
10	2,509,011,381	1,581
15	2,178,195,375	1,565
20	1,905.519,676	1,548

3.3.3. BEP calculation

The results of the break even point (BEP) calculation for charcoal production show that the BEP volume value is 177,196 tons and the BEP value is IDR 888,979,900. If the business unit wants to make a profit, it must produce and sell products in quantities of more than 177,196 tons. On the other hand, if this business unit produces below 177,196 tons, it will certainly suffer a loss. The condition of the charcoal production business is in a profitable condition, because it produces 360 tons during one year's production process..

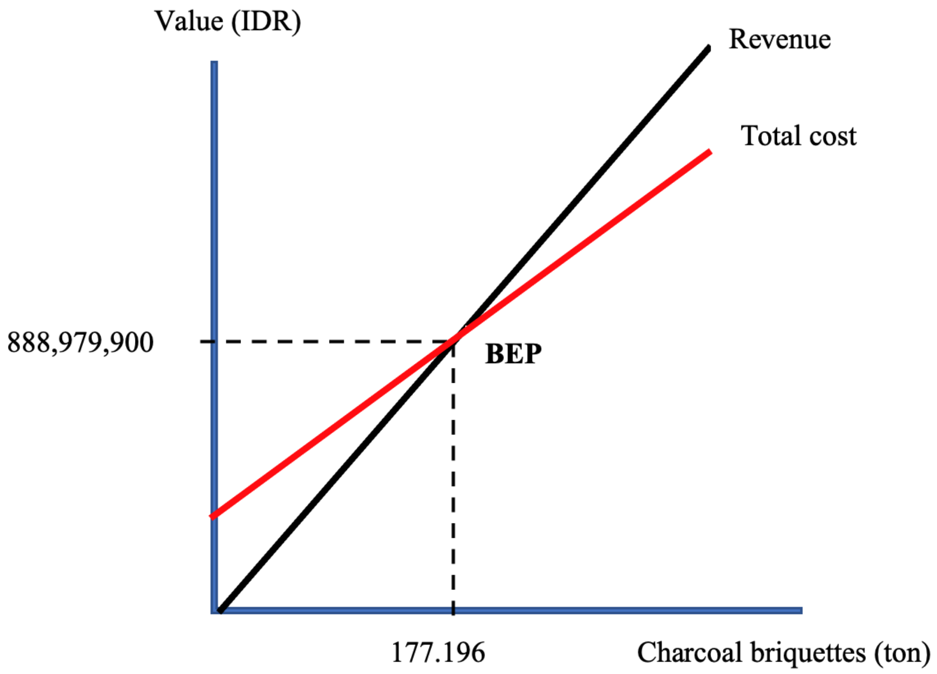

Fig.2. BEP graphical of charcoal briquette production

4. Conclusion

Based on the data from the experiments that have been carried out, the following conclusions can be drawn:

The results of the characterization of young coconut coaat waste charcoal briquettes obtained physicochemical properties: volatile matter content 26.74%, ash content 2.76%, fixed carbon content 68.66%, density 0.62 g/cm^3, firmness 32.44 kg/cm^3 , and calorific value 6.21 cal/g. In this way, young coconut shell waste charcoal briquettes meet quality standards as alternative energy based on SNI and Japanese Standards.

The simulation results of the production of charcoal briquettes from coconut waste with a capacity of 5 tons per day can determine the NPV (net present value) and B/C ratio values at different interest rates, namely 10, 15 and 20 percent, turned out to be positive NPV values and B/C ratios with a value of more than one. This shows that the charcoal production business was feasible to run.

The business unit wants to make a profit, it must produce and sell products in quantities of more than 177,196 tons. On the other hand, if this business unit produces below 177,196 tons, it will certainly suffer a loss.

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