Biochar Briquette Makings from Cashew Nut Shell Waste and Soybean Empty Pods as Energy Alternative Sources of Stove

Wuye Ria Andayanie, Retno Iswati, Martin Lukito, Praptiningsih Gamawati Adinurani

Merdeka Madiun University. Serayu 79, Madiun, 63133, wuye_andayanie@yahoo.com

Abstract

Biobriquette is one of the alternative fuel which expected to be able to replace the kerosene and LPG. The aim of this study was to obtain the optimum basic formulation to getting quality standards of biochar briquette. The experiment used a randomized completely block design with four replications. Production of briquettes follow some processing steps i.e grinding 40 mesh screening, mixing with starch binder, briquetting and drying 65 °C for 24 h. The variables choose as the independence variable were cashew nut shell and soybean empty pods. The compositions of waste (50 %, 75 % and 100 %) and concentration of tapioca starch binders 3 %. The parameters observed in the experiment were average burning time and flame color. The result showed that composition of material affected the quality of briquette produced. The composition of cashew nut shell (100 %) was the best on moisture content (7.18 %), ash content 5.09, volatile matter 40.46, Fixed carbon 40.25, and calorific value (6438 cal/gr). The average burning time of briquettes was 128 min with yellowish colour flame.

Keywords: Briquette, cashew nut, soybean, empty pods, waste.

1. Introduction

Growing development of Indonesian economy, energy consumption is increasing day by day. Renewable energy sources are being sought for domestic cooking because nonrenewable such as kerosene and LPG are expensive. In addition, the high cost of non-renewable energy sources has made to use of renewable energy sources for domestic cooking. Biomass briquettes are often used as an energy source for cooking and industries like bricks. Fuelwood is the primary energy source for cooking used by rural house hold (50 %) in Indonesia [1–3]. Biomass briquettes many hold the answer for emerging and developing countries, as well as countries which are more established [4]. In Wonogiri region the cashew (Anacardium occidentale L.) is one of the major horticultural crops. Biomass, a domestic energy sources is naturally abundant and presents renewable energy that could provide an alternative to use of fossil resources.

The waste biomass generated in cashew processing is utilized as a substitute to wood fuel by making charcoal with carbonization and are among the most important renewable fuels in use today. Energy and waste management policy initiatives should include recovery of organic by product for fuel briquette production [5]. Charcoal briquettes production has renewed to use that
can be easily stored and transported. The agro industrial residues are cashew nut shell and soybean empty pods which can be converted into density fuel briquettes [6]. Cashew nut shell are one type of the most abundant biomass tropical wastes, which can be used as energy alternative sources of stoves. The waste biomass generated in cashew processing is utilized as a substitute to wood fuel by making charcoal with carbonization and are among the most important renewable fuels in use today.

The average higher heating value of the cashew nut shell briquettes was found 4890.23 kcal/kg in the laboratory testing. Cashew nut shell briquettes burnt with good flame in cook stove and observed 15.5 percent thermal efficiency. Better results in cashew shell briquettes related to caloric value, resistance to water penetration, tumbling test and water boiling test [7, 8].

Cashew nut shell wastes are a serious problem in the environment in Wonogiri, Indonesia. These wastes are mainly on the farm or burnt with all the ecological problems. Cashew nut shell waste utilization in order to increase the added value of agricultural wastes. One way to reduce oil consumption and use the land is the utilization of cashew nut processing waste into biocharcoal briquettes, where the constituent ingredient derived from cashew nut shell. The purpose of this research was to obtain cashew nut shell composition with soybean empty pods to make briquettes for energy generation.

2. Material and Methods

2.1. Study area

The experimental process briquette production was done at the Agrotechnolgy Laboratory of Agriculture Faculty of Merdeka Madiun University and Food Science Technology Laboratory of Gajah Mada University. The cashew nut shell and soybean empty pods were collected in Wonogiri area where the materials are produced in large quantities. Biomass preparation

2.2. Biomass preparation

Cashew nut shell and soybean empty pods was dried under the sun for 2 d. The carbonized cashew nut shell and soybean empty pods were used as major constituents for briquetting without any binding material.

2.3. Carbonization of cashew nut shell

The carbonized of biomass material samples were obtained by burning in metal kiln. A kiln made up of cylindrical metal drum which in accommoded about 20 kg biomass materials. Kiln was closed after placing the cashew nut shell and soybean empty pod waste for the carbonization. Soybean empty pod waste were done to transfer of heat.

2.4. Preparation of char powder, binder and mixing

The wastes dried were cut into small pieces (about 0.5 inch.) and filter using a mesh (40 Mesh). Different combination as: 100:0, 75:25, 50:50 for cashew nut shell and soybean empty pods were
made observing the properties of briquettes. The carbonized char powder mixed with tapioca starch (tapioca boiled water for 10 min) as binder. Water was added as a medium to facilitate good mixing. Concentration of tapioca starch binders 3%.

2.5. Biobriquettes production

Hidraulic jack is used to make biomass briquette compaction. The compositions are the fixed variable such as the size briquette 4 cm and total weight/briquette 30 g; Biomass briquette were dried temperature 65 °C for 24 h until a constant weight to determine the moisture content of the product.

3. Result and Discussion

Carbonization process of cashew nut shell produced char and solid residues with increasing of the element carbon were formed from the organic material. Carbonization process developed prototype kiln. Please see Figure 1.

**Figure 1.** Single drum kiln was used carbonization processes

Fixed carbon and volatile matter directly contribute to the calorific value briquette. Fixed carbon acts as generator burning. Volatile matter indicated easy ignition of fuel. Cashew nut shell has a higher calorific value than soybean empty pods. Ash content has a negative effect on the calorific value. Soybean pods empty added to the cashew nut shell has a low calorific value and does not affect the calorific value of briquettes. Proximate analysis of cashew nut shell and its char for determination of moisture content, ash content, volatile matter, fixed carbon was carried out. It was observed that moisture content of the cashew nut shell 7.18 ± 0.03 (%) while moisture content in soybean empty pods 7.94 ± 0.08 (%). It could also be observed that ash content in cashew nut shell sample was less than that of the soybean empty pods. The results of proximate analysis are shown in table 1.

**Table 1.** Result of proximate analysis of biomass composition

<table>
<thead>
<tr>
<th>Biomass composition</th>
<th>Fixed carbon (%)</th>
<th>Volatile matter (%)</th>
<th>Moisture content (%)</th>
<th>Ash content (%)</th>
<th>Calorific value (cal/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNS (100 %)</td>
<td>40.25 ± 0.07</td>
<td>40.49 ± 0.11</td>
<td>7.18 ± 0.03</td>
<td>5.09 ± 0.04</td>
<td>6438.29 ± 17.36</td>
</tr>
<tr>
<td>SEP (100 %)</td>
<td>8.38 ± 0.04</td>
<td>72.31 ± 0.16</td>
<td>7.94 ± 0.08</td>
<td>16.45 ± 0.06</td>
<td>5190.15 ± 16.18</td>
</tr>
</tbody>
</table>
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The cashew nut shell more composition than empty soybean pods waste will affect burning rate. Soybean pods empty will cause large pores, thus speeding up the process of combustion. Briquettes which have the length of burning rate will have a high calorific value. Please see Figure 2 and Table 2.

![Figure 1. Cashew nut shell briquettes (100 % composition) with colour flame](image)

Table 2. Effect cashew nut shell composition on the length combustion time and colour flame

<table>
<thead>
<tr>
<th>Variable composition</th>
<th>Burning rate</th>
<th>Colour flame</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 %</td>
<td>Weight CNS = 30.0 g</td>
<td>128 minutes</td>
</tr>
<tr>
<td>75 %</td>
<td>Weight CNS = 22.5 g, Weight SEP = 7.5 g</td>
<td>102 minutes</td>
</tr>
<tr>
<td>50 %</td>
<td>Weight CNS = 15.0 g, Weight SEP = 15.0 g</td>
<td>71 minutes</td>
</tr>
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</table>

Table 2 obtained information that the briquettes from the CNS produces light yellowish colour and CNS and SEP (50 %) combination produces light yellowish and blue. Components of biobriket have an influence on the colour flame. Cashew nut shell contains oils that consist of compound cardol, cardanol, anacardic acid.

4. Conclusion

The conclusion of experiment showed that usage of cashew nut shell 100 % have the most calorific value. Maximum fixed carbon percentage found as 40.32 %. In addition, this filter cake briquettes produced low ash content. Combination of CNS and CEP (75:25 %) showed the lower calorific rate and burning rate than cashew nut shell 100 %.
5. Acknowledgements

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6. References


