A preliminary study of biomass briquettes based on biochar from pyrolysis of durian shell

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Abstract. Utilization of durian shell waste as feed biomass in the pyrolysis process has been carried out. The results of the pyrolysis process produce bio-oil, gas, and biochar. Pyrolysis biochar can be used as a potential source of energy by converting it into biochar briquettes. This research is making biochar briquettes using a mixture of water and starch. The ratio between biochar and starch is 9:1. The mixed material is then made biochar briquettes using a briquette printer with a pressure of 0.5 MPa. The results showed that biochar briquettes had better performance than durian shell biomass.

1. Introduction

Indonesia has much durian shell waste during the harvest season. The existence of this waste has a negative impact as well as a positive impact. Negative impacts are environmental pollution and unpleasant odors. Meanwhile, the positive impact is the potential for durian shell waste to be used as biomass. Research trends related to renewable energy are currently showing a tremendous increase, such as waste to energy [1][2][3][4][5], Turbine [6][7], and biofuel [8][9][10][11].

Durian shell contains the main components of biomass such as cellulose, hemicellulose, and lignin. Utilization of durian shell waste can be converted into biomass and continued with the pyrolysis process. Pyrolysis is a chemical decomposition process using fast or slow heating without using oxygen. In the pyrolysis process, it produces three substances, namely solids, liquids, and gases. The resulting solid is char. Char can be used as biochar briquettes. According to Syamsiro and Harwin, 2007 [12] explained that biochar briquettes have advantages compared to conventional (conventional) charcoal. When burned, biochar briquettes do not cause odor, so they are suitable for use in urban areas that have insufficient ventilation. Biochar briquettes also do not require flaking after ignition in contrast to charcoal made from wood.

The production of biochar briquettes as a result of the pyrolysis of durian shell biomass is expected to produce alternative fuels that contain high carbon, have high calorific value, and burn for a long time. For this reason, this research focuses on the use of biochar from the pyrolysis process into biochar briquettes.
2. Research Method
This research is a preliminary study of making biochar-based briquettes from durian shell pyrolysis. Pyrolysis was carried out at a temperature of 400 °C. The first step in the research was chopped and sieved durian shell waste with a mesh size of 10. The durian shells that had been mashed and sifted were mixed with mashed durian seeds. Durian shells mix with durian seeds by ratio of 7: 3. Durian seeds function as a biomass binder. The result of this process becomes biomass of durian shell. Biomass of the durian shell enters the pyrolysis process with a temperature of 400 °C. The results of the pyrolysis process produce bio-oil, gas and biochar. Each sample of charcoal is then made briquettes. The process sequence can be seen in Fig. 1.

Briquetting biochar used a mixture of water and tapioca flour. The ratio between biochar and starch is 9: 1. The mixed material is then made biochar briquettes using a briquette printer with a pressure of 0.5 MPa. The next step is the briquette drying process for six days to reduce moisture content. Dry briquettes were tested for the calorific value and proximate value of RDF, namely moisture content, ash content, carbon content, and fixed carbon content.

Figure 1. Pyrolysis process of durian shell biomass
3. Result and Discussion

3.1 Drying process of briquettes biochar

Figure 3 shows the biochar briquettes before drying and after drying. The briquette drying process is carried out for five days, with 4 hours per day. The results of measuring the weight of briquettes biochar can be analyzed that the sufficient drying time is three days with a duration of 4 hours of drying, as shown in Fig. 4. After three days of drying, the weight of the biochar briquettes began to be constant. Biomass measurement parameters were carried out after the briquettes were allowed to stand for 72 hours. This was aimed at stabilizing the dimensions of the briquettes. After the briquette process, the biochar briquettes have a diameter of 10mm and a length of 50mm, and an average weight of 5.2 gr.

![Figure 3. Biochar briquettes before drying and after drying](image)

![Figure 4. Drying process](image)

3.2 Calorific value of durian shell biomass vs. briquettes biochar

The heating value is the amount of heat released by biochar briquettes in a unit weight or volume unit during complete combustion. The calorific value is measured using a bomb calorimeter. Measurement data can be seen in Table 1. The calorific value of biochar briquettes is greater than the initial raw material of the durian shell's biomass. These results indicate that the pyrolysis process at a temperature of 400 C can produce biochar briquettes with a higher calorific value than the initial raw material (Biomass of durian shell).

| Indicator         | Biomass of durian shell (Non-RDF) | Briquettes based on biochar from pyrolysis of durian shell |
|-------------------|-----------------------------------|----------------------------------------------------------|
| calorific value   | 3478.66 calorie/gram              | 5196.5 calorie/gram                                      |
3.3 The moisture content of durian shell biomass vs. briquettes biochar

Moisture content analysis is needed to determine the water content in the briquettes. Water content affects the initial ignition during combustion. The lower the moisture content obtained, the better the quality of the biochar briquettes. On the contrary, the higher the water content, the worse the biochar briquette quality. Table 2 shows that biochar briquettes’ water content is lower than the biomass of the durian shell. Where durian shell biomass has a moisture content of 13.323% and biochar briquettes have a moisture content of 8.54%.

| Indicator          | Biomass of durian shell (Non-RDF) | Briquettes based on biochar from pyrolysis of durian shell |
|--------------------|----------------------------------|----------------------------------------------------------|
| Moisture content   | 13.323 %                         | 8.54 %                                                   |

3.4 Volatile content of durian shell biomass vs. briquettes biochar

Volatile content is needed to determine the content of flying substances in biochar briquettes. Volatile levels are formed from flammable gases (carbon monoxide, methane gas, hydrogen) and non-flammable (carbon dioxide and nitrogenic gases). Volatile content affects the ability of biochar briquettes to ignite and burn. If the volatile level is high, the fuel is flammable, whereas if the volatile level is low, the fuel is difficult to ignite. Table 3 shows that the volatile content of durian shell biomass is higher than that of biochar briquettes.

| Indicator          | Biomass of durian shell (Non-RDF) | Briquettes based on biochar from pyrolysis of durian shell |
|--------------------|----------------------------------|----------------------------------------------------------|
| Volatile content   | 60.287%                          | 22.801 %                                                 |

3.5 Ash content of durian shell biomass vs. briquettes biochar

Ash content analysis is used to comply with the ash content remaining after burning biochar briquettes. The remaining ash content is a mineral that cannot burn completely during the burning process of biochar briquettes. Table 4 shows that biochar briquettes have higher ash content than durian shell biomass.

| Indicator | Biomass of durian shell (Non-RDF) | Briquettes based on biochar from pyrolysis of durian shell |
|-----------|----------------------------------|----------------------------------------------------------|
| Ash content | 3.61 %                          | 12.57%                                                   |

3.6 The fixed carbon content of durian shell biomass vs. briquettes biochar

Fixed Carbon levels were used to determine the amount of carbon content in a material. The higher the fixed carbon content, the longer the fuel combustion process will take. Table 5 shows that the levels of fixed carbon briquette biomass are higher than durian shell biomass.
Table 5. The fixed carbon content of durian shell biomass vs. briquettes biochar

| Indicator                  | Biomass of durian shell (Non-RDF) | Briquettes based on biochar from pyrolysis of durian shell |
|----------------------------|-----------------------------------|----------------------------------------------------------|
| Fixed carbon content       | 22.78%                            | 55.58%                                                   |

4. Conclusion
Research is preliminary biochar-based study briquetting results pyrolysis at temperatures of 400 C. The results showed that the briquettes biochar has performance is better than the shell durian biomass. The details of the research results are as follows:

a. The sufficient drying time for biochar briquettes is three days, with a drying time duration of 4 hours per day. After the briquette process, the biochar briquettes have a diameter of 10mm and a length of 50mm, and an average weight of 5.2 gr.

b. The calorific value of biochar briquettes is greater than the initial raw material of the durian shell's biomass. These results indicate that the pyrolysis process at a temperature of 400 C can produce biochar briquettes with a higher calorific value than the initial raw material (Biomass of durian shell).

c. The level of fixed carbon briquette biomass is higher than durian shell biomass.

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