A Study of the Efficiency of Charcoal Briquettes from Canarium Sabulatum Guillaumin and Xylia Xylocarpa

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Abstract. This research aims to produce charcoal briquettes from Canarium Sabulatum (Canarium Sabulatum: tapioca starch) at the ratio of 8:2 and from Xylia Xylocarpa at the ratio of 7:3 (Xylia Xylocarpa: tapioca starch). The method that is used in this research is a cold press process by using a screw extruder that is connected with a 3.5 horsepower electrical motor. The finished charcoal briquettes of this method are compared with another finished charcoal briquette that uses a different emulsifier by analysing thermal energy, amount of ashes, density, burning time, and a pattern of charcoal crackle. The analysis helps to determine which ingredients are the best for producing the best charcoal briquettes. The result found that the production of charcoal briquettes from Canarium Sabulatum and Xylia Xylocarpa in both ratios results in briquettes with smooth surface, is completely dry, and is firmly formed in a bar shape. The thermal energy analysis showed that the charcoal briquettes that were mixed at the ratio 8:2 has the maximum thermal energy at 25.917 MJ/kg and pass Thai Community Products Standards (TCPS 238/2547) which indicated that the thermal energy must not be less than 5,000 calories/gram or 20.920 MJ/kg. The density is also calculated and it was found that the charcoal briquettes from Xylia Xylocarpa at the ratio 7:3 has the best density at 735.74 kg/m³. It is similar to a previous research that stated the density of charcoal briquettes must not be more than 0.8 g/cm³ or 800 kg/cm³. In regard to the amount of ashes, it showed that the charcoal briquettes from Canarium Sabulatum and Xylia Xylocarpa in both recipes have more ashes than the previous research. The burning time showed that the charcoal briquettes from Canarium Sabulatum at the ratio of 8:2 has the most burning time which is 326 minutes and is similar to the previous research. The previous research stated that the burning time of the charcoal should last more than 60 minutes. The last analysis regarding the pattern of charcoal crackle showed that the charcoal briquettes from Canarium Sabulatum and Xylia Xylocarpa in both recipes have no crackle and good quality according to the Thai Community Products Standards (TCPS 238/2547).

1. Introduction

From the mid-20th century until now, the main energy that we have been consuming is oil and natural gas. Oil is considered as a limited and non-renewable resource. It is predicted that in about 50 years from now that oil will be very expensive, and will not be worth to use as the main resource to produce...
products. Thus we will have to find new energy resources that are less expensive to replace the oil. Thailand has mainly imported energy from other countries. According to data in 2011, Thailand imported 80% of total national oil consumption [1]. The energy consumption is still increasing according to the economic growth. The petroleum products accounted for the most at 49.7% of final energy consumption, and the need for energy continues to increase because Thailand does not produce enough petroleum for national consumption [2]. In 2012, Thailand only consumed alternative energy at 18.2% of total energy, which was more than the last year at only 1.8%. There was an increasing in solar energy and biofuel consumption at 23%, however, the consumption of the energy from firewood, husk, and agricultural residues were reduced to 10%. The reason may be that the biomass was transformed to biofuel [3].

People nowadays realize that the resources should be worthily used and should recycle those resources to maximize the capacity before discarding. Biomass can produce thermal energy and this energy can be used to generate electricity. Thailand has a potential to use biomass to generate electricity not less than 3,000 megawatts [4]. That is why the biomass should be reused such as to make fertilizers or charcoals.

The charcoal briquettes can be produced in a small industry in order to increase a community’s income. There are 2 production methods, including a hot press process and cold press process. The process of hot press is to compress natural materials that are not charcoals to be briquettes by using heat. However, the hot press machine has high costs. Another method, cold press process, also uses natural materials but these materials are needed to be burned to be charcoals first by using a cold press machine. However, it needs an emulsifier to combine charcoal particles together and form the charcoals into a bar shape. The emulsifiers that are normally used are flour glue, or sugar such as charcoal briquettes produced from corncobs [5]. The thermal energy that comes from corncob charcoal briquettes can be another alternative way to reduce energy consumption, waste pollution, and increase value of biomass waste. It also helps to generate income for communities.

The researcher realizes that natural resources are very important, should be worthily used, and maximize their capacity. To maximize the capacity, the natural resources will be transformed instead of letting them naturally decompose. The study of charcoal briquettes production uses Canariums Sabulatum and Xylia Xylocarpas that are available in the community. This will help to reduce the consumption of wood charcoals which directly results in reduce deforestation. It also helps to reduce cost of fuel to use in a household and to use alternative energy.

2. Methodology

2.1 Materials
Xylia Xylocarpas, Canarium Sabulatums, Tapioca Starch, Water

2.2 Tools
A 200 ml charcoal burner tank with lid, a digital scale, An Automatic Adiabatic Bomb calorimeter, a screw press machine

3. Procedures
Part 1 Charcoal briquettes production from Canarium Sabulatums and Xylia Xylocarpas.

Step 1 Prepare materials
Dried Canarium Sabulatums and Xylia Xylocarpas in the sun to reduce burning time.

Step 2 Burn charcoals
The following steps are about burning the charcoals regardless of the moisture.

1. Dug a hole that was deep enough for a 200 ml charcoal burner tank. Then filled some firewood to half of the tank and put Canarium Sabulatums and Xylia Xylocarpas on top of the firewood. Lit the burner by using rubber as fuel. During the burning, there was some white smoke from the tank. The smoke came from the evaporation of the moisture from the wood pieces. The lid was left ajar to let the smoke out.
2. Continuously provided the heat to the tank by filling up the fuel. When the smoke increased, the fuel filling was stopped. The smoke would then decrease and change to a blue colour.

3. After 6-8 hours, the smoke would almost finish. It meant that the Canarium Sabulatums and Xylia Xylocarpas started transforming to charcoals. When the smoke finished, the fruits had already transformed to charcoals. Then closed the lid tightly and poured some soil on top of the lid to seal any other holes in order to prevent air from getting in to the tank. It was left it overnight. The process was finished.

4. Putting the soil on top of the tank was to cool down the heat inside the tank. Left it overnight until no fire was on the charcoals, and then opened the lid to collect the charcoals. If the charcoals are still burning, spray some water to put out the fire. Let the charcoals cool before collecting and sorting the charcoals according to the materials.

Figure 1. Charcoals from Canarium Sabulatum
Figure 2. Xylia Xylocarpa
Figure 3. Examples of charcoal briquettes in each ratio

Step 3 Charcoals compressing
1. Finely ground the charcoals. After collecting the charcoals from step 2, the charcoals were finely ground by using a grinder. Finely ground charcoals makes the compress process easier.
2. The following table is the ratio of charcoal power and emulsifier.
3. Combined charcoal power with the emulsifier according to the table 1 and put the mixed ingredients in the screw press machine and dried the finished charcoals in the sun.

Part 2 Comparison between the charcoal briquettes from Canarium Sabulatums and Xylia Xylocarpas with the different emulsifier at the different ratio
1. Found the thermal energy from both charcoal briquettes by testing in the Bomb Calorimeter and took note and found the density of the charcoal briquettes from this formula:

\[ \rho = \frac{m}{V} \]  

when \( \rho \) is the density of the object (kg/m³)
\( m \) is mass of the object (g)
\( V \) is volume of the object (cm³)

2. The weighed 500 grams of charcoal (before burning) and burned them all, then weighed the amount of ashes with a digital scale. Took pictures and calculated the amount of ashes from this equation:

\[ \% \text{ amount to ashes} = \frac{w_0}{w_1} \times 100 \]

when \( w_0 \) is an example of charcoals (weight before burning)
\( w_1 \) is an example of charcoals (weight after burning)

3. Observed a pattern of charcoal crackles and took pictures and took note the burning time.

4. Analytical results
   Analysis of the physical and chemical property of the produced charcoal briquettes as shown in the table 1
Table 1. Physical and chemical property of charcoal briquettes.

| Property of charcoal briquettes | Canarium Sabulatum: Tapioca starch (8 : 2) | Canarium Sabulatum: Tapioca starch (7 : 3) | Xylia Xylocarpa: Tapioca starch (8 : 2) | Xylia Xylocarpa: Tapioca starch (7 : 3) |
|---------------------------------|--------------------------------------------|--------------------------------------------|----------------------------------------|----------------------------------------|
| Thermal energy (MJ/Kg)          | 25.917                                     | 24.163                                     | 22.798                                 | 24.694                                 |
| Amount of ashes (%)             | 7.68                                       | 6.92                                       | 6.01                                   | 6.23                                   |
| Density (kg/m³)                 | 915.23                                     | 902.16                                     | 721.73                                 | 735.74                                 |

The analysis of physical and chemical property showed that the thermal energy of charcoal briquettes from Canarium Sabulatums at the ratio of 8:2 is 25.917 MJ/kg. According to the Thai Community Products Standards (TCPS 238/2547), it is determined that the thermal energy must not be less than 5,000 calories/gram or 20.920 MJ/kg. Therefore, all charcoal briquettes in this study met the criteria of the Thai Community Products Standards (TCPS 238/2547). In regard to the amount of ashes, it was found that all charcoal briquettes have high amount. However, a previous study stated that the amount of ashes should not be more than 5%. The density of the charcoal briquettes from Canarium Sabulatums at the ratio of 8:2 has high density at 915.23 kg/m³ because Canarium Sabulatums have a hard shell and are heavy. This result is different from the previous study. While the charcoals from Xylia Xylocarpas at the ratio of 7:3 have lower density at 735.74 kg/m³ which is similar to the previous research.

In regard to the burning time, it was tested with 500 grams of charcoal briquettes and found that the charcoal briquettes from Canarium Sabulatums at the ratio of 8:2 last the longest at 326 minutes. It is because these charcoals have high density which make the burning time longer. It was also found that all charcoal briquettes in all recipes are similar to the previous research.

All the produced charcoal briquettes have no crackle pattern because all charcoals have smooth surface, is solid and nicely form in a bar shape. According to the Thai Community Products Standards (TCPS 238/2547), it stated that charcoal briquettes should not have any crackle pattern. Therefore, the charcoal briquettes in this study meet the criteria of the TCPS.

5. Conclusion

1. All charcoal briquettes that were produced from Canarium Sabulatums and Xylia Xylocarpas by using the cold press process with the screw press machine that was connected to a 3.5 horsepower electric motor were in good quality. They all met the criteria of Thai Community Products Standards, and the previous research study. The finished products had a smooth surface, were completely dry, and solid.

2. When comparing the thermal energy of the charcoal briquettes from Canarium Sabulatums and Xylia Xylocarpas, it was found that the charcoal briquettes from Canarium Sabulatums at the ratio of 8:2 had more thermal energy at 25.917 MJ/kg.

3. When comparing the amount of ashes from both charcoal briquettes in all ratios, it was found that they all produced too many ashes which didn’t meet the standards.

4. When comparing the density of all charcoal briquettes from all recipes, it was found that the charcoal briquettes from Xylia Xylocarpas had a perfect density at 735.74 kg/m³.

5. When comparing the burning time of all charcoal briquettes in all ratios, it was found that the charcoal briquettes from Canarium Sabulatums at the ratio of 8:2 had the best burning time at 326 minutes.

6. When comparing the crackle pattern of all charcoal briquettes from all ratios, it was found that the charcoal briquettes from both fruits had no crackle pattern and met the criteria of Thai Community Products Standards.
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