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# Improving Fuel Potential of Para Rubber Wood Bottom Ash as Charcoal Briquette with Co-Extruded Materials

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**ABSTRACT**

The objective of this research is (1) to study the properties of charcoal briquette of para rubber wood bottom ash (PRBA) from the biomass power plant and (2) to improve the quality of charcoal briquette by adding the co-extruded materials i.e. coconut shell charcoal powder (CSCP), Palmyra shell charcoal powder (PSCP) and mangrove charcoal powder (MCP). This research consists of three parts. The first part studies the properties of para rubber wood bottom ash and the co-extruded materials. The second part produces the charcoal briquette from para rubber wood bottom ash mixed with the co-extruded materials of various ratios. The ratios of the para rubber wood bottom ash to the co-extruded materials are 10:0, 9:1, 8:2, 7:3, 6:4, 5:5, 4:6, 3:7, 2:8 and 0:10 kg. The mixture of charcoal briquette is 10 kg of extruded materials, 1 kg of tapioca starch and 1 L of water. For compression purpose, the tapioca starch is used as a binder. The third part analyzes the properties of charcoal briquette of PRBA with the co-extruded materials that provides the best quality. From the results, the mixture ratios that provide the heating value results meet the Thai community product standards charcoal bar 238/2547 include the mixture ratio of PRBA-PSCP of PRBA: PSCP is 4:6, 3:7, 2:8 and 0:10 kg, the mixture ratio of the PRBA: MCP is 2:8 and 0:10 kg, and the mixture ratio of PRBA: CSCP of 4:6, 3:7, 2:8 and 0:10 kg. According to the standard, the heating value of charcoal briquette should be equal to or higher than 5,000 cal/g. Therefore, it can be concluded that the optimum ratios for charcoal briquette of PRBA with co-extruded materials are 4:6 of PRBA: PSCP, 2:8 of PRBA with MCP and 4.6 of PRBA with CSCP because it meets the standard and it provides the maximum utilization of bottom ash for para wood rubber from the biomass power plant.

**Keywords :** fuel**;** para rubber wood bottom ash; charcoal briquette; co-extruded materials

## INTRODUCTION

Energy is an important factor in economic development and quality of life for people in the country. The current growing in economic, society and industry results in the higher energy demand from the past and provides an increasing trend in the future. Limited energy sources in the country are resulting in the use of agricultural or biomass waste materials as an energy source for producing electricity which causes the biomass power plant of various sizes distributed in the regions. Currently, the biomass power plants are up to 177 plants [1]. Biomass power plants are important sources of pollution that may cause problems with nearby communities and the surrounding environment, therefore they must have an effective pollution management. The pollution is dust between 30-80 mg/kW. The electrostatic precipitator is used for air pollution treatment due to its high efficiency. The carbon monoxide (CO) quantity is uncertain depending on the combustion efficiency, and one of the main pollutants is ash which is considered an industrial waste. The ash contains the alkaline properties, caused by an incompletely combustion process, it can be divided into bottom ash and fly ash.

Charcoal briquette uses biomass or waste that is burned into charcoal and then compressed into mold, or bring the fuel briquettes that are compressed into mold and pass to the burning process. The material that is suitable for forming into charcoal briquette, must have fuel properties such as heat value, etc. The para rubber wood bottom ash has a relatively high carbon content [2], causing in the high heating value suitable for forming into charcoal briquette to be used as fuel. It also increases the stability and sustainability of energy. The charcoal briquette can help the biomass power plant managing the issues of bottom ash and reduce the impact on the environment.

## METHODOLOGY

### Raw materials

Fig.1 shows the raw materials of the charcoal briquette production, (A) the para rubber wood bottom ash (PRBA) used in this study from the biomass power plant. The PRBA is dried with sunlight until the moisture content is less than 8%. The co-extruded materials consist of (B) coconut shell charcoal powder (CSCP), (C) Palmyra shell charcoal powder (PSCP) and (D) mangrove charcoal powder (MCP) are compressed for charcoal briquette. Tapioca starch is used as a binder.

(A) (B) (C) (D)

**Fig.1 Raw materials for charcoal briquette production**

The proximate analysis consists of heating value, moisture content, volatile matter, fixed carbon and ash content. The ultimate analysis includes carbon, oxygen, hydrogen, nitrogen and sulfur of the raw materials. The proximate analysis is followed by ASTM. The carbon, oxygen, hydrogen, nitrogen and sulfur analysis by CHNS/O analyzer, Flash 2000, Thermoscientific, Italy.

**The ratio for briquette production**

The ratio of the para rubber wood bottom ash (PRBA) to the co-extruded materials such as coconut shell charcoal powder (CSCP), Palmyra shell charcoal powder (PSCP) and mangrove charcoal powder (MCP) are shown in Table 1. The mixture ratio of PRBA and co-extruded materials is 10:0, 1:9, 2:8, 3:7, 4:6, 5:5, 6:4, 7:3, 8:2 and 0:10 kg. The mixture of charcoal briquette is 10 kg of extruded materials, 1 kg of tapioca starch and 1 L of water. The tapioca starch is used as a binder.

**Procedure for charcoal briquette production**

Fig.2 shows the procedure for charcoal briquette production. In this study, the cold compression is used for briquette process. (E) The raw materials are reduced the moisture content to less than 8%. After that, (F) the raw material and co-extruded material are mixed with the tapioca starch and water. Then, (G) the mixture is compressed in a mold. (H) The charcoal briquette is 4 cm in diameter, 10 cm in length, and 1.5 cm of hole at the center area. After that, the charcoal briquette is dried by sunlight to reduce the moisture content.

**Table 1. The ratio of charcoal briquette production**

| PRBA: Co-Extruded materials (kg) | Tapioca starch (kg) | Water (L) |
|---|---|---|
| 10:0 | 1 | 1 |
| 1:9 | | |
| 2:8 | | |
| 3:7 | | |
| 4:6 | | |
| 5:5 | | |
| 6:4 | | |
| 7:3 | | |
| 8:2 | | |
| 0:10 | | |

(E) (F) (G) (H)

**Fig. 2 Procedure for charcoal briquette production**

**Analytical methods for charcoal briquette**

The proximate analysis for charcoal briquette consists of heating value, moisture content, volatile matter, fixed carbon and ash content. The proximate analysis is followed by ASTM.

## RESULTS AND DISCUSSIONS

**The properties of raw materials**

The para rubber wood bottom ash (PRBA) contains 2,182 cal/g of heating value, 6.4% of moisture content, 15.3% of volatile matter, 3.9% of fixed carbon and 74.5% of ash content. The results show that the heating value of PRBA does not meet the charcoal briquette quality of standard [3], due to the low heating value for charcoal briquette production. The heating value of the para rubber wood bottom ash does not meet the quality standard [3], it needs to be improve for product of charcoal briquette by mixing with coconut shell charcoal powder (CSCP), palmyra shell charcoal powder (PSCP) and mangrove charcoal powder (MCP). From the result, the properties of raw materials are shown in Table 2.

**Table 2 Properties of raw materials**

| Properties | Materials | | | |
|---|---|---|---|---|
| | PRBA | CSCP | PSCP | MCP |
| **Proximate analysis** | | | | |
| Heating value (cal/g) | 2,182 | 6,843 | 6,720 | 6,429 |
| Moisture content (%) | 6.4 | 6.6 | 3.9 | 4.8 |
| Volatile matter (%) | 15.3 | 70.0 | 70.4 | 69.6 |
| Fixed carbon (%) | 3.9 | 23.1 | 22.6 | 19.3 |
| Ash (%) | 74.5 | 0.6 | 3.0 | 5.8 |
| **Ultimate analysis** | | | | |
| Carbon (%) | 19.3 | 80.9 | 75.4 | 67.0 |
| Nitrogen (%) | 0.10 | 0.21 | 0.86 | 0.26 |
| Oxygen (%) | 22.4 | 7.7 | 12.7 | 21.2 |
| Hydrogen (%) | 4.6 | 2.4 | 2.9 | 3.7 |
| Sulfur (%) | 0.10 | > 0.01 | 0.07 | 0.17 |

**Charcoal briquette**

The ratio of the para rubber wood bottom ash to the co-extruded materials for charcoal briquette production is 10:0, 9:1, 8:2, 7:3, 6:4, 5:5, 4:6, 3:7, 2:8 and 0:10 kg. The result of PRBA with co-extruded materials as charcoal briquette properties test is shown below.

1. Moisture content (MC)

Fig. 3 shows the results of the MC of PRBA mixed with co-extruded materials. The MC of all charcoal briquettes must meet the requirement of Thai community production standard 238/2547, therefore they are drying by sunlight [4]. According to the standard, the MC of all charcoal briquettes is less than 8%, which is low and can be a good indicator of solid fuel. If the charcoal briquette contains high MC, then the heating value decreases [3].

2. Volatile matter (VM) and Fixed carbon (FC)

The results show the trend of VM (Fig. 4) and FC (Fig. 5) of PRBA mixed with co-extruded materials. The amount of VM and FC increases when the co-extruded material increases. The VM and FC values are important parameter for identifying the heating value of solid fuel. Due to the high VM and FC, the charcoal briquette has a high heating value and can be ignited for a long time [3, 5].

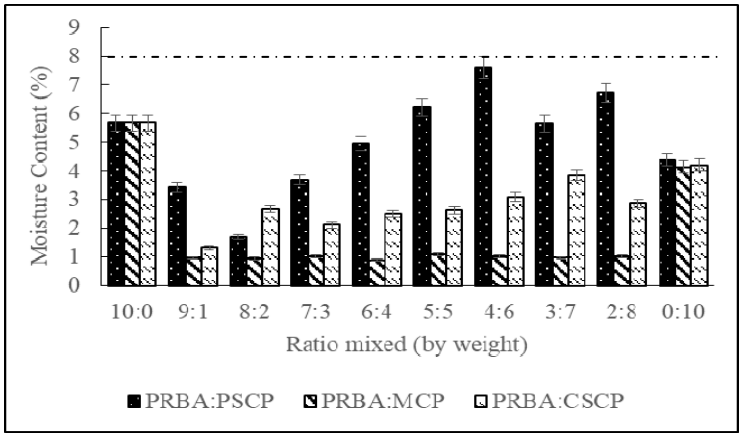


**Fig. 3 MC of PRBA mixed with co-extruded materials**

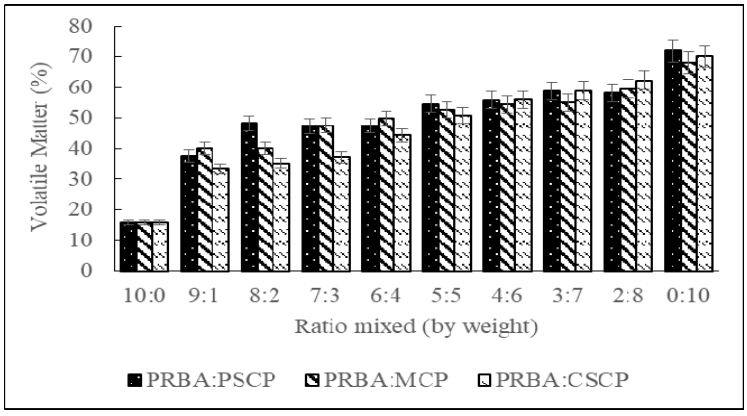


**Fig. 4 VM of PRBA mixed with co-extruded materials**

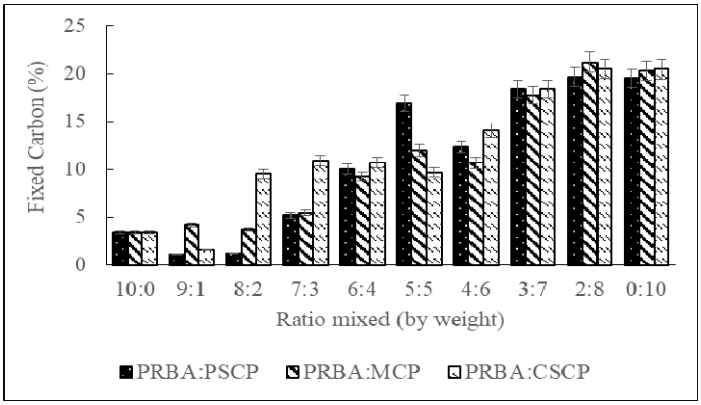


**Fig. 5 FC of PRBA mixed with co-extruded materials**

3. Ash content

Fig. 6 shows the results of ash content of PRBA mixed with co-extruded materials for charcoal briquette production. When the co-extruded materials are of a large portion in the mixed ratio, the ash content will decrease. The ash content of a good fuel should be less than 20%.

4. Heating value

The results show the trend of the heating value of PRBA mixed with co-extruded materials (Fig. 7). The heating value increases when the co-extruded materials increases. The mixture ratio of the PRBA: PSCP of 4:6, 3:7, 2:8 and 0:10 kg, the mixed ratio of the PRBA: MCP of 2:8 and 0:10 by weight, and the mixture ratio of the PRBA per CSCP of 4:6, 3:7, 2:8 and 0:10 kg, the heating value results meet the Thai community product standards charcoal bar 238/2547. According the standard, the heating value of charcoal briquette should be equal to or higher than 5,000 cal/g [4].

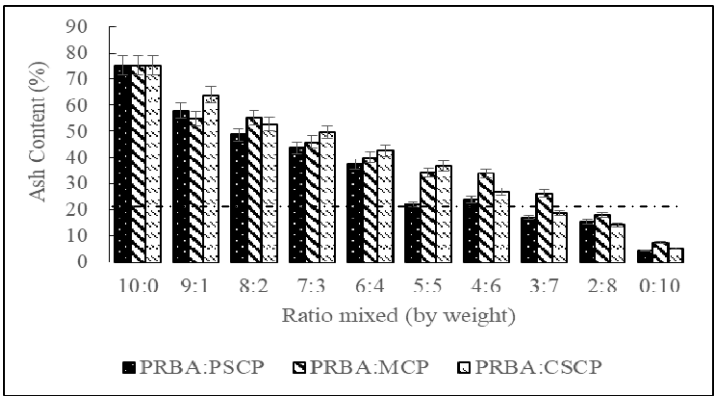


**Fig. 6 Ash content of PRBA mixed with co-extruded materials**

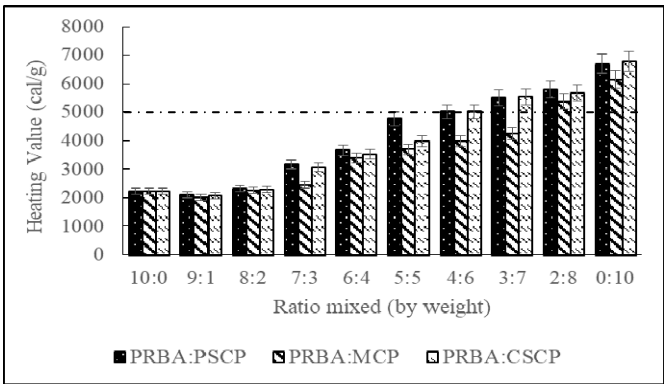


**Fig. 7 Heating value of PRBA mixed with co-extruded materials**

## CONCLUSIONS

The utilization of PRBA as charcoal briquette can be used as fuel for cooking or other activities, including the production of charcoal briquette for sale. The results can be concluded that the optimum ratios for charcoal briquette of PRBA with co-extruded materials are 4:6 of PRBA with PSCP, 2:8 of PRBA with MCP and 4:6 of PRBA with CSCP which meets the standard and provides the maximum utilization of para wood rubber bottom ash from biomass power plant.

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