

# The effect of raw material composition of mixed carbonized canary shell and coal bio briquettes on caloric value

*by Nurliah Jafar*

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## The effect of raw material composition of mixed carbonized canary shell and coal bio briquettes on caloric value

S Widodo<sup>1\*</sup>, N Asmiani<sup>2</sup>, M Azwan<sup>2</sup>, N Jafar<sup>2</sup>, A Artiningsih<sup>2</sup>, S R Nurhawaisyah<sup>2</sup>, Harwan<sup>2</sup>, C A Chalikh<sup>2</sup>, M Thamrin<sup>3</sup>, and J R Husain<sup>3</sup>

<sup>1</sup>Mining Engineering Department, Engineering Faculty, Hasanuddin University, Makassar, 90245, Indonesia.

<sup>2</sup>Mining Engineering Department, Faculty of Industrial Technology, Muslim University of Indonesia, Makassar, 90231, Indonesia.

<sup>3</sup>Geological Engineering Department, Engineering Faculty, Hasanuddin University, Makassar, 90245, Indonesia.

\*Corresponding author: [srwd007@yahoo.com](mailto:srwd007@yahoo.com)

**Abstract.** The fuel consumption rate rises and is expected to increase continuously, causing fuel supplies to be depleted and this condition forces the community to find alternative sources of fuel such as bio-briquettes. The waste of canary shells is widespread in Indonesia and can be used as an alternative energy source of bio-briquette making. There is a need for study on the influence of raw materials bio-briquette mixture of coal and canary shells against the value of calories produced. Bio-briquette making in this study have been done using canary shell and coal with a composition: (250 gr coal/canary shell: 12.5 tapioca starch: 50 ml water). Before briquette making, the canary shell samples are pirolised and a grain-size reduction is performed on both of coal and canary shells. Canary shell and coal bio-briquettes are made with four variations (types). The types of bio briquette are: type I of bio-briquette with a composition of 250 gr (coal) + 12.5 gr (tapioca starch) + 50 ml (water). Type II of bio-briquette with a composition of 250 gr (canary shell) + 12.5 gr (tapioca starch) + 50 ml (water). Type III of bio-briquette with a composition of 62.5 gr canary shell + 62.5 gr coal + 12.5 gr (tapioca starch) + 50 ml (water). Bio-briquette type IV consist of 93.75 gr (canary shell) + 31.25 (coal) + 12.5 gr (tapioca starch) + 50 ml (water). After preparation, all bio briquettes are analyzed to determine the caloric value. The results of the study shows bio-briquette type I has a caloric value of 5,539 kcal/g, bio-briquette type II produces the highest calorie value of 6,354 kcal/g, and bio-briquette type III is 6,020 kcal/g. Further more bio-briquette Type IV indicate caloric value of 6,096 kcal/g. Bio-briquette type IV is the most recommended in the utilization because of the goal of this study is to use canary shell as an alternative fuel.

### 1. Introduction

The use and utilization of today's biomass material is growing, as the more fuel usage extends from simple fuels such as firewood, oil and gas usage from small-scale industrial sectors, as well as to the large scale industries. This energy depletion problem is resulted the human seeking and diversification on alternative energy [1].

Oil consumption rate is rising in its defense and is expected to increase continuously, so the supply of oil in Indonesia will be depletion. With these conditions, various attempts are made to reduce dependence on oil, one of which utilizes an alternative source of energy. There are many alternative energy sources in Indonesia, one of which is organic waste materials that can be used as alternative fuel, for example briquette making from various organic material resources [2-15].

Canary is an indigenous plant in Indonesia that grows in the eastern part of Indonesia [16]. Canarys consist of the outer shell, the fruit flesh, and the shell parts. The shell or shell parts are generally no longer used by the public so that there is an increase in canary shell waste. Therefore,



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it can be used as an alternative ingredient of briquette making. Scientifically the utilization of the bio-briquette is still developed, because there are not many variations of mixture that use the material from this waste.

To know the quality of coal bio-briquette that will be utilized there are several ways to do, among them are conducting research on the influence of mixed raw materials for coal briquette using canary shells.

Some studies of coal in Indonesia, especially in Kalimantan and Sulawesi Island have been done and provided important information for our recent study [17-23]. Our study focus on the utilization of canary shell and coal as bio briquette with variation of mixture composition (briquette types I, II, III, and IV). Mixture of canary shell and coal as bio-briquette types I, II, III, and IV will be compared on the caloric value after analyses.

## 2. Samples and Methods

The sample processing is done in the Mineral Processing Laboratory of Indonesian Muslim University's and Hasanuddin University, as well as at the laboratory of PT Sucofindo. The stages of sample processing consist of two parts, namely canary shell and coal processing. The processing of both samples is almost identical, only different in the initial sampling process.

Samples of canary shell or coal powder and adhesives mixed into a container and stir until mixed. After that the sample that has been mixed was molded and compacted using a push tool. Samples of the canary briquettes are dried in the sun for two days. A briquette that has been dried is then inserted into the sample bag and labelled as grain size. The stages of coal processing is similar to the processing stage of canary shells, the difference coal is not carbonized by burning but only pounded using a hammer and crushed using jaw crusher. The next stage equals the canary shell stage. The bio-briquette composition (four types) is then taken to the laboratory of PT Sucofindo for caloric value analyses (testing).

## 3. Results and Discussion

The results of the study on the effect of raw materials composition of carbonized canary shell and coal mixed bio-briquette to caloric value are shown as follows:

### 3.1. Analysis of coal, canary shells, and the carbonized canary shells

Coal samples parameters analysis shows the value of moisture content (MC) of 13.92%, ash content (AC) of 1.30%, volatile matter (VM) by 44.83%, fixed carbon (FC) at 39.95%, total sulfur (TS) of 0.080% and the value of calories (CV) of 6,214 cal/g. Canary shell samples (un-carbonized) parameters analysis indicate a value of moisture content (MC) of 8.19%, with ash content (AC) amounted to 1.08%, with volatile matter (VM) of 21.05%, fixed carbon (FC) of 69.68%, total sulfur (TS) of 0.026% and caloric value (CV) of 4,387 cal/g. Furthermore carbonized canary shell samples parameters analysis exhibit the value of moisture content (MC) of 1.92%, ash content of 3.83%, volatile matter by 27.79%, fixed carbon at 66.46%, total sulfur of 0.016% and caloric value of 6,790 cal/g. The detailed result of coal, canary shells, and carbonized canary shell analysis are shown in Table 1.

**Table 1.** Results of the analysis of coal, canary shells, and carbonized canary shells.

| Parameters/Unit | Coal  | Canary | Carbonized canary shell |
|-----------------|-------|--------|-------------------------|
| MC (%)          | 13.92 | 8.19   | 1.92                    |
| Ash (%)         | 1.30  | 1.08   | 3.83                    |
| VM (%)          | 44.83 | 21.05  | 27.79                   |
| FC (%)          | 39.95 | 69.68  | 66.46                   |
| TS (%)          | 0.080 | 0.026  | 0.016                   |
| CV (cal/g)      | 6,214 | 4,387  | 6,790                   |

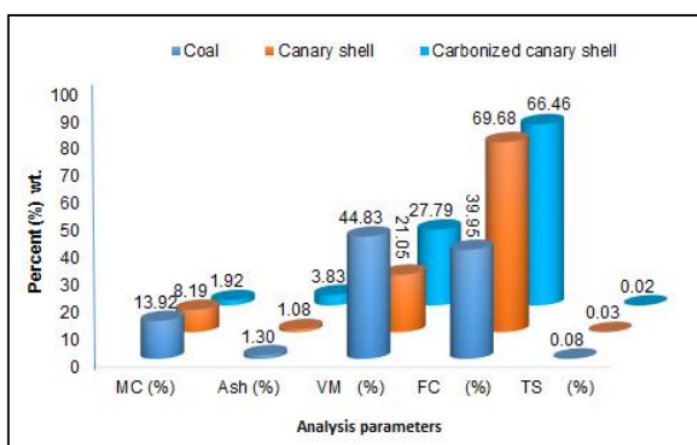
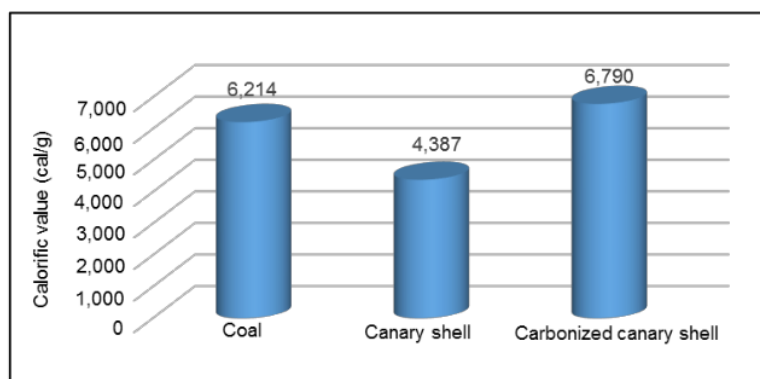


Figure 1. Analysis results MC, Ash, VM, FC, coal TS, canary shells, and carbonized canary shells.

**Figure 2** The calorie value of coal, canary shell, and the carbonized canary shell.

### 3.2. The composition of the bio-briquette preparation (canary shell and coal)

In the process of making bio-briquette done the first is to weigh the composition of coal, carbonized canary shells, tapioca starch, and water. The tapioca starch and water that has been then mixed and heated using a pan until it becomes viscous like glue. The coal and carbonized canary shells that have been then mixed with the tapioca starch are mixed evenly. After that, the ingredients that have been mixed are inserted into the mold. The sample that has been made then compacted with the mold/press tool. The briquette that has been pressed is then released from the mold and carried out a drying under the sunlight for 1-2 days. Furthermore sample of bio-briquette from canary shell and coal that has been dried will be delivered to the laboratory of PT Sucofindo to analyze the value of calories.

### 3.3. Bio-briquettes mixture of canary shell and coal (bio briquette types)

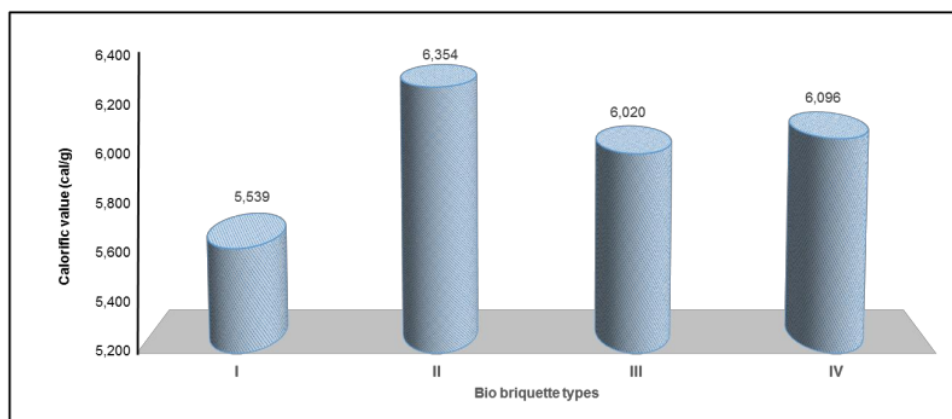
The types and composition of bio briquette in this study are shown in Table 2. There are four types of bio briquette with a calorific value of 5,539 cal/g (100% coal), 6,354 cal/g (100% carbonized canary shell), 6,020 cal/g (50:50% coal and carbonized canary shell), and 6,096 cal/g (25:75% coal and carbonized canary shell).

**Table 2.** Bio briquette types and the composition of carbonized canary shell and coal.

| Briquette type                           | Material composition |              |                |       | Calories Value |
|------------------------------------------|----------------------|--------------|----------------|-------|----------------|
|                                          | Coal                 | Canary Shell | Tapioca Starch | Water |                |
| I Coal 100%                              | 125 gram             | -            | 12.5 gram      | 50 ml | 5,539 cal/g    |
| II Carbonized canary shell 100%          | -                    | 125 gram     | 12.5 gram      | 50 ml | 6,354 cal/g    |
| III Coal: carbonized canary shell 50:50% | 62.5 gram            | 62.5 gram    | 12.5 gram      | 50 ml | 6,020 cal/g    |
| IV Coal: carbonized canary shell 25:75%  | 31.25 gram           | 93.75 gram   | 12.5 gram      | 50 ml | 6,096 cal/g    |

The comparison between bio-briquette calories produced is quite good because the average value of calories above 5,000 cal/g (based on Indonesian National Standard number S 01-6235-2000). From the results of the analysis of bio-briquette calorie value has been produced, **bio-briquette type II** has the highest calorie value of 6354 cal/g. While the **bio-briquette** that the author recommend for utilization is bio briquette type IV with a calorie value of 6096 cal/g. This is due to the use of canary shells and coal as the main raw materials to produce bio-briquettes with a high calorific value. Utilization of canary shells as waste can be an action to save and diversify energy utilization.





**Figure 3.** Comparison of bio-calorie value in canary shell briquettes and coal.

### 3.4. Factors influencing the study results

The factors that affect the study result are:

- Manual pressure on the manufacturing process of briquette which allows the given pressure is not homogeneous on each samples.
- The mixing of sample composition manually allows the mixing of samples which is not uniform.
- Samples are limited due to many experiments making briquettes with grain size and also mixing raw materials such as water content and tapioca starch are different to compare in terms of strong quality press and calorie value.
- Decreased calorie value due to water content and tapioca starch as adhesive material.

## 4. Conclusion

From the analysis that has been done with the same grain size and various kinds of composition, it can be obtained the result that the bio-briquette of type I with coal composition 100% (125 g) coal, 12.5 g tapioca Starch, 50 ml of water, obtained a calorie value of 5539 cal/ g. The second type of bio-briquette with canary shell composition of 100% (125 g) canary shell, 12.5 g tapioca starch, 50 ml of water, obtained a calorie value of 6,354 cal/g. Bio-briquet of type III with a composition of coal 50% (62.5 g), canary shell 50% (62.5 g), 12.5 g starch tapioca, 50 ml water obtained calorie value 6020 cal/g. Bio-briquet type IV with a composition of coal 25% (31.25 g), canary shell 75% (93.75 g), 12.5 tapioca starch, and 50 ml of water, obtained a calorie value of 6,096 cal/g. The bio-briquette type IV is most recommended in the utilization of bio-briquette coal and canary shells. This is due to the use of canary shells and coal as the main raw materials to produce bio-briquettes with a high calorific value. Utilization of canary shells as waste can be an action to save and diversify energy utilization.

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