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## Pre-Design of Bio-Briquette Production Using Kenari Shell

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# Pre-Design of Bio-Briquette Production Using Kenari Shell

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**Abstract.** At present, coconut shell charcoal briquettes are one of the alternative energy sources that are in demand by the export market. The purpose of this research was to produce an alternative briquette product based on local natural materials. Kenari shell is a waste of natural materials or biomass. The characteristics of Kenari shells have the same structure with coconut shell. The pre-design of briquette production of this Kenari shell used pre-treatment process stages, charcoal making, destruction, printing with adhesive variation, drying, and SNI quality of briquette quality analysis. The results of pre-design of bio-briquette production of Kenari shell showed that the application of the method and the basic ingredients of waste could produce the product of charcoal briquettes equal to charcoal briquettes of coconut shell.

**Keywords:** Bio-briquettes, shell, kenari (*Canarium indicum* L.), pre-design, production

## 1. Introduction

One of the big issues in this current time is the phenomena of the energy crisis, global warming, and the decreasing of oil fuels derived from fossils. Therefore, those cases provide opportunities for the development and use of alternative energy sources (green energy) [1,2]. One of the main ingredients of alternative energy sources in question is biomass plants that are also include as renewable energy [3]. Biomass is a natural material that is considered as waste and often destroyed by burning [4,5]. Kenari (*Canarium indicum* L.) shells is categorized as biomass from the seed harvesting in Makian island, North Maluku, Indonesia. Hence, it can be used as an alternative fuel by creating it into bio-briquettes [6,7].

North Maluku is one of the Kenari plant's hotspots in Indonesia, one of place that widely distributes plants and forests is Makian island [8]. Kenari (*Canarium indicum* L.) is a native walnut plant in Indonesia and has the potential to be developed as food and drug products [9]. The use of kenari plants by the local community till current time only on the seeds part as food ingredients, spices and cooking ingredients [10]. Meanwhile, the peel and shells of kenari are not utilized. Kenari seed shells and shells are the primary sources of lignocellulose which has the potential to manufacture renewable energy based on biomass utilization [11,12]. Bio-briquettes is a type of solid fuel made of biomass raw materials with a little adhesive mixture [13–15]. Biomass in everyday life, is a biological material which is usually considered as garbage and often destroyed by burning [16,17]. The benefits of using charcoal briquettes, among others, are lower cost than that of oil or charcoal, charcoal



briquettes which have a much more extended burn period; the use of briquettes is relatively safer; briquettes are easily stored and moved; there is no need to fan or add new fuel repeatedly [18,19]. With these various advantages, the role of charcoal briquettes as the alternative fuels has been recognized in various countries [20–22]. So far, the type of briquettes of coconut shell charcoal is one of the favorite alternative energy sources and is in great demand by domestic and export market share [23,24]. Briquettes as an export commodity must have stable quality and the quality requirements of Indonesia standard of product aka SNI 06-3730-95 [25]. Bio-briquette made of coconut shell and other similar materials is a form of renewable energy that is feasible to be developed in Indonesia. One of the ingredients of a coconut shell which has the potential to be developed into bio-briquette in North Maluku is Kenari's (*Canarium indicum* L.) seed shell waste. This study aimed to produce bio-briquette products and build a model for the development of regional superior research-based bio-briquette making technology. This research is expected to contribute to policies based on problem solving of people's needs for future energy sufficiency.

## 2. Methods

The main ingredients used in this study were Kenari (*Canarium indicum* L.) shells, starch, cocoa pulp, and sago flour. The equipments that were used: drum author, sitting scales, machetes, printing, sieves, pounders/buckets, buckets, stainless steel blades, measuring cups, stoves, ovens. The equipment for product analysis included platinum or porcelain plates, broccoli, digital balance, desiccators, weigh bottles, porcelain dishes, drying ovens. This research was conducted in June until August 2018 in the Integrated Basic Laboratory at Khairun University. The sampling technique was purposive. The raw material was gathered at Makian island in the form of fresh kenari fruit. Then the kenari fruit got peeled and was taken from the shell to be processed into bio-briquette. The procedure for making bio-briquettes (Figure 1) is carried out through the stages: roasting, crushing, printing, and drying as well as bio-briquette quality analysis.

### 2.1. Making Charcoal

The process of carving (carbonization) of Kenari's shells used the following working techniques: the clean Kenari's shell was arranged in a place of charcoal in the form of iron drums, and it was closed tightly and burned until the shell gets black and became charcoal.

### 2.2. Preparation of Making Charcoal Briquettes

Kenari's shells that had become charcoal were then smoothed by using a pounder, then sifted with 50 mesh to get the results of charcoal powder.

### 2.3. Mixing

The charcoal powder was sifted finely, then filtered using a 50 mesh sieve; each was weighed 1 kg, mixed with 100 g of adhesive which had been dissolved in 100 of 900 mL water. The adhesives used were starch, sago and brown pulp.

### 2.4. Bio-briquette printing

Printing was done after the dough was evenly distributed, then printed with a manual briquette printing tool by inserting a mixture of briquette mixture into the printing hole as many as eight holes, then pressed or pressed, with one printing produces eight pieces of cylindrical charcoal briquettes

### 2.5. Drying

The charcoal briquette batter made of the printed walnut shell will be cylindrical (long round) in a wet and brittle condition, so it needs special drying treatment using a drying oven and drying technique at the temperature of 125 °C for 48 hours or drying at the sunshine and free air for seven days.

### 2.6. Analysis of briquettes quality

The bio-briquettes that had been dried were measured in terms of water content, ash content, bounded carbon content, evaporating content, and time to reach the boiling point.



**Figure 1.** The stage of Kenari's shell briquette production

## 3. Results and Discussion

Characteristics of Kenari's bio-coal briquettes in this study referred to SNI 01-6235-2000 and ASTM D 1542-02.2003 [26–28] including moisture content, ash content, fixed carbon content, vaporized substances, and the time to reach boiling points (Table 1).

**Table 1.** Analysis of Kenari's bio-coal briquettes

Variety of briquettes	Moisture content (%)	Ash content (%)	Fixed carbon content (%)	Vaporized substances (%)	Time to reaches the boiling point of 100 mL of water (minutes)
Kenari's Charcoal + Starch	4.30	12.85	55.90	27.00	26
Kenari's Charcoal + sago	3.03	10.55	67.18	20.25	26
Kenari's Charcoal + brown pulp	3.58	8.55	67.50	21.90	27

### 3.1. Moisture Content

Determination of water content aims to determine the hygroscopic properties of charcoal bio-briquettes. Bio-coal briquettes water content produced in this study ranged from 3.03-4.30% (Table 1). The highest moisture content was obtained from the treatment with the addition of starch flour, and the lowest one was attained from the treatment with the addition of sago flour. Good briquettes should have a little amount of moisture content that can be helped by a loose structure of briquettes that let the water to easily vapourize [28–30]. It means that a mixture of Kenari's shell and sago flour gave the best result in this study. Nevertheless, the water content generated from this study met the activated charcoal quality standards based on SNI 063730-95 ( $\leq 8\%$ ) and based on ASTM D 1542-02.2003 ( $\leq 6.2\%$ ).

### 3.2. Ash Content

Determination of the ash content of bio-coal briquettes was carried out to determine the content of heavy metal oxides in bio-coal briquettes [31]. In this study, the resulted ash content ranged from 8.55-12.85% (Table 1). The lowest ash content of bio-coal briquettes was produced in the addition of brown pulp treatment and the highest yield was due to the addition of starch. The results of the study of ash content did not reach the activated charcoal quality standards according to SNI 06-3730-95 ( $\leq 8\%$ ) and ASTM D 1542-02.2003 ( $\leq 8.3\%$ ) in all treatments.

### 3.3. Fixed carbon content

Determination of fixed carbon content on bio-coal briquettes aims to determine the carbon content after the carbonization process, high value of fixed carbon indicates that the result is made up mostly from carbon [32]. The bound carbon content produced in this study ranged between 55.90-67.50% (Table 1). The lowest bonded carbon content was produced from the addition of starch flour and the highest was on the addition of cocoa pulp treatment. The result from all treatment in this study didn't reach the requirement for SNI 06-3730-95 (77%) and but still reach for ASTM D 1542-02.2003 (60%) especially from treatment with sago and brown pulp.

### 3.4. Vaporized substances

The purpose of determining the vaporized content was to find out the volatile compounds of bio-coal briquettes at 950 °C. The high amount of volatile compounds would make the fixed carbon content of bio-coal briquettes lower and vice versa [33]. In this study, the levels of volatile substances resulted in the range of 20.25-27.00% (Table 1). The lowest volatile content was obtained from bio-coal briquettes with the highest addition of sago flour and the addition of starch. From the results of this study, all levels of volatile substances produced did not meet the activated charcoal quality standards based on SNI-01-6235-2000 (15%) but they were still relevant based on ASTM D 1542-02.2003 (19-28 %).

### 3.5. Time to reaches the boiling point of 100 mL water

The purpose of determining the time to reach this boiling point was to find out how long it took the bio-coal briquette to reach the boiling point of (100 °C) 100 mL of water. In this study, the time to reach the water boiling point ranged from 26-27 minutes (Table 1). The time to reach the fastest boiling point was obtained from bio-coal briquettes with the addition of sago flour and the longest treatment with the addition of brown pulp treatment.

## 4. Conclusion

In summary, the results of our study showed that the mixture of Kenari's shell and sago flour was better for every category (moisture content, ash content, fixed carbon content, vaporized substances, and the time to reach boiling points) then followed by the addition of brown pulp and the last was starch. Actually, the ash content, fixed carbon content, and vaporized content resulted by all treatments did not reach the limit according to SNI 06-3730-95 except for moisture content. Then, only the ash content from all treatments and fixed carbon content from Kenari's shell with starch did not reach the standard limit based on ASTM D 1542-02.2003.

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