

## MAKING BRIQUETTES FROM ORANGE SKIN WASTE AND SUGARCANE BAGASS USING PYROLYSIS METHOD

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### ABSTRACT

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*The availability of domestic raw materials is gradually decreasing, while the need for energy sources is increasing. Therefore, it is necessary to have the availability of renewable energy sources, one of which is biomass. In this study, researchers will discuss the waste of sugarcane bagasse and orange peel which can be used as briquettes. Usually, these wastes are only used as animal feed, sometimes they are just thrown away. The goals and benefits expected by the author in this study are, to provide information that the manufacture of briquettes from bagasse and Pacitan orange peel can be used as an alternative fuel. So, it can be implemented to reduce fossil fuels, whose availability is getting less and less. In the study, the best results were on the adhesive variable 20% ratio 1:2 with a calorific value of 5,949,114 cal/gram, 9% moisture content, 9% ash content.*

### KEYWORDS

Bagasse, Briquettes, Energy, Orange Peel



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## INTRODUCTION

Charcoal is a solid that has pores made from the carbonization process. Therefore, most of the charcoal pores are still covered by hydrocarbons, tar, and other compounds containing components of tethered carbon (such as ash, water, nitrogen, and sulfur). Meanwhile, biochar is alternative energy made from biomass raw materials such as rice husks, wood, twigs, leaves, grass, straw, or other agricultural wastes.

Biobriquettes can be made from biomass raw materials. Biomass is one of the alternative energy sources produced from plants either directly or indirectly in large quantities. Biomass can be used directly without carrying out the carbonization process, but the resulting benefits will be less efficient. An example is the use of wood which is used as fuel, the energy used is less than 10%. The energy produced from burning wood is only 2,300 kcal/g while the energy that can be produced from burning biochar can reach 5,000 (Maulinda & Mardinata, 2019).

Briquettes are a form of alternative energy that is currently being developed and is sourced from biomass containing carbohydrates, especially cellulose. Briquette fuel compared to other fossil fuels is cheaper, lighter, obtained easily, has economic value, and so on. Charcoal briquette raw materials can come from all organic materials because it contains lignocellulose which is a natural polymer with high molecular weight which is rich in energy. Based on this definition, many choices of opportunities can be taken. In every place throughout the archipelago, organic waste is always found as a by-product of industrial and agricultural activities. For example, rice husks, straw, sawdust, water hyacinth, leaves, grass, peat cocoa dust, and household waste are potential raw materials for charcoal briquette production (Setiawan & Syahrizal, 2018).

Charcoal briquettes are charcoal made from other types of charcoal which are ground first and then molded as needed with a mixture of starch. The purpose of making charcoal briquettes is to increase the duration of burning time and save costs. Charcoal briquettes can be used as an alternative to petroleum or fossil fuels. Petroleum or fossil fuels are non-renewable natural resources. The process of making charcoal briquettes is easy and the raw materials are easy to obtain (Ramadhani, Hidayah, & Pramesti, n.d.).

The advantages of using charcoal briquettes include, the cost is cheaper than oil or wood charcoal, charcoal briquettes have a much longer fuel life, the use of briquettes is relatively safer, briquettes are easy to store and move, do not need to be fanned many times or add to the new fuel. With these advantages, the role of charcoal briquettes as an alternative fuel has been recognized in various countries (Muhammad, Parnanto, & Widadie, 2018).

Biochar briquettes have several advantages over (conventional) charcoal, including the heat generated by biochar briquettes is relatively higher than ordinary wood and the calorific value can reach 5000 calories. Biochar briquettes when burned do not produce smoke or odor, so for economically weak communities living in urban areas where housing ventilation is insufficient, it is very practical to use biochar briquettes. After the biochar briquettes burn (become coals) there is no need for fanning. The technology of making biochar briquettes is simple and does not require other chemicals except those contained in the briquette material itself. The equipment used is also simple, with the existing tools being shaped as needed and there is no need to look elsewhere (Hartanto, 2011).

Briquette is a material in the form of small pieces of powder that are compacted using a press machine with mixed adhesive so that it becomes a solid form. The change in the size of the material is carried out through a coagulation process with emphasis and addition or without the addition of a binder. Charcoal briquettes are made by mixing materials that have a high carbon value and by compressing them at a certain pressure and

heating at a certain temperature so that the water content can be kept to a minimum so that the resulting fuel has a high density, high calorific value and minimum exhaust fumes (Ningsih, 2019).

Biochar can be reprocessed through processing so that it can be a biochar briquette product. Briquettes are solids in the form of lumps made of soft raw materials, then hardened. Meanwhile, biochar briquettes are lumps made of biochar. Several factors will affect the properties of charcoal briquettes, namely the specific gravity of the charcoal powder or the type of fuel, fineness of the powder, carbonization temperature, compression pressure, and mixing formula (Fachry, 2010).

By making briquettes from orange peels, it is an effort to convert biomass residues into renewable energy. Several things need to be considered to make quality bio briquettes, namely the selection of raw materials used, water content, temperature, addition of substrate, and particle size.

Biobriquette compared to ordinary charcoal made from wood is very different. Biobriquettes are cleaner when used, can produce perfect heat, require relatively narrow storage space. To compete in the briquette market, namely briquettes that have met quality standards, chemical, and physical properties also greatly affect the quality of briquette fuel.

Table 1. Briquette Quality Standards in Several Countries

Properties of Charcoal Briquettes	Indonesia	Japan	England	USA
Water content (%)	8	6-9	3-6	6,2
Volatile matter content (%)	15	15-30	16,4	19-24
Ash content (%)	8	3-6	5,9	8,3
Carbon content (%)	77	60-80	75,3	60
Density (g/cm <sup>3</sup> )	-	1-1,2	0,46	1
Pressure strength (kg/cm <sup>3</sup> )	-	60-65	12,7	62
Calor value (cal/g)	5000	6000-7000	7289	6230

(Maulinda, 2019).

Quality briquettes to be used as fuel must also meet physical criteria, such as:

- Easy to turn on
- Does not emit smoke
- Combustion gas emissions are non-toxic
- Watertight and combustion products do not get moldy when stored for a long time
- Shows good combustion rate (time, rate of combustion, and combustion temperature) (Fachry, 2010).

Bagasse is a by-product produced from the sugarcane juice milking process which ranges from 35 to 40 % of the weight of the milled sugarcane (Sugiharto, 2021). Chemically bagasse components contain cellulose, polyose, hemicellulose, lignocellulose, and lignin groups (Maulinda, 2019).

Bagasse can also be said as a by-product of the sugarcane juice extraction process which has a fiber length of about 1.7 – 2.2 mm with a diameter of 20 m. Bagasse fiber is insoluble in water because most of its content is cellulose, pentosan, and lignin (Yosephin, 2018).

Table 2. Chemical Composition of Bagasse

Content	Rate (%)
Ash	3
Lignin	0,79
Cellulose	44,7
Pentosan	12,7
Solubility in Hot Water	3,7

Pacitan oranges are one of the most abundant fruits in Indonesia. Has a sweet taste, has a lot of water content, contains vitamin C which ranges from 27-49 mg/100 grams of fruit flesh. Citrus juice contained in Pacitan oranges ranges from 40-70 mg of vitamin C per 100 mL. Depending on the type of orange, the older it is, the less the vitamin C content will be (Kusuma, 2007).

One of the benefits of orange peel is to make pectin. Pectin is a polymer compound that can bind water, form a gel, or thicken a liquid. This property can be utilized so that apart from jelly, pectin is also used in the meat industry and other food products that require a water binder (Aji, 2018).

The Adhesive is a material that can be used to glue or bind two objects through a surface bond so that the addition of - adhesive material can make the bonds between particles stronger. So that the grains of charcoal briquettes will stick together and cause water to also be bound in the pores of the charcoal. The function of the addition of adhesive can also affect the quality of the briquettes produced, namely at the time of ignition and combustion (Sugiharto, 2021).

Based on the use and quality, the selection of adhesive materials can be classified as follows:

a. Based on the nature/raw material of briquette gluing

Has good cohesion when mixed with coal, is flammable and smokeless, easy to obtain in large quantities and at affordable prices, does not emit odor, is non-toxic, and harmless

b. By type

The types of raw materials that are generally used are inorganic adhesives and organic adhesives. Examples of inorganic binders are cement, clay, and sodium silicate. While examples of organic binders are starch, tar, asphalt, starch, molasses, and paraffin. As for those using adhesive from tapioca, caustic soda which has a concentration of 98%, and clay. Of the several types of adhesives, the most frequently used is starch adhesive (Fachry, 2010).

The pyrolysis or devolatilization method is a process of chemical decomposition of materials, where the process takes place by heating in the absence of oxygen or a little oxygen. Pyrolysis technology is usually used to convert organic waste that is not used optimally so that it can be turned into biomass. The pyrolysis process produces a product in the form of a solid fuel called carbon, a liquid mixed with tar and other substances. Other products formed in the form of carbon dioxide gas, methane, and other gases have a very small content. The results of pyrolysis are three types of products, namely solid charcoal, gas, and bio-oil. Generally, the pyrolysis method takes place at temperatures above 300 °C within 4-7 hours (Ridhuan, 2017).

The quality parameters of briquettes need to be considered because they will affect the benefits and uses of briquettes, some of these parameters are:

- Calorific value

The calorific value can be obtained by burning a sample of briquettes using a tool called the Bomb Calorimeter by returning the system to the ambient temperature. Net

Calorific Value is usually between 93-97% of Gross Value and depends on the Inherent Moisture content and hydrogen content in the briquettes. The calorific value is a quality parameter that is known for the maximum amount of heat energy released by fuel, the amount is obtained due to the complete combustion reaction of the unit mass or volume of the fuel. The purpose of the calorific value test is to obtain data on the heat energy that can be liberated by fuel by the occurrence of a reaction or combustion process.

- Proximate analysis

It is an analytical test to determine the moisture content, fixed content, ash content, and volatile matter. The higher the volatile matter content, the lower the calorific value. Meanwhile, the higher the fixed carbon value, the higher the calorific value (Wijaya, 2020).

- Water content

There are two types of water vapor, namely free and bound water vapor. Free water vapor can be lost by evaporation for example by water-drying. While the bound water vapor is determined by heating the briquettes between temperatures of 104-110 °C for one hour

- Ash content

All briquettes contain inorganic substances which can be determined as the remaining weight if the briquettes are burned completely. The substance left behind is called ash. Ash produced by briquettes is produced from clay, sand, and various other mineral substances. Briquettes with a high ash content are very unprofitable because they will form a crust

- The content of volatile substances

The volatile matter produced from briquettes consists of flammable gases. Such as hydrogen, carbon monoxide, and methane gas. Volatile matter is part of the briquette which will turn into a product when the briquette is heated without air at a temperature of approximately 950 °C (Fachry, 2010):

Table 3. Biobriquette Quality Standards based on SNI 01-6235-2000

Test type	Unit	Condition
Water content	%	Max 8
Part lost on heating 90	%	Max 15
Calorie ash content	%	Max 8
ADBK	cal/gr	Min 5000

(Wijaya, 2020).

Table 4. Biobriquette Quality Standard

Parameter	SNI
Water content (%)	<8
Ash content (%)	<8
Carbon content (%)	>77
Caloric value (cal/g)	>5000

Source: Forestry Research and Development Agency (1994) in Wijayanti (2009)

## RESEARCH METHOD

This study aims to determine the potential of sugarcane bagasse and orange peel waste that can be used as raw materials for making bio-briquettes. This research was carried out at the Chemical Engineering Laboratory and in Panggungrejo Village. This research was carried out using the pyrolysis method, to produce bio briquettes from bagasse and orange peel raw materials.



The fixed variable used in this research is the pyrolysis method. With a carbonization time of 4 hours, the volume of water is 250 mL, the mass of raw materials (orange peel and bagasse) is 1 kg, and the drying time is 3 days. The control variables that we use are bagasse and orange peel raw materials. While the independent variables in this study were the ratio of bagasse and orange peel, 1:1; 1:2; 1:3; 1:4; bagasse 100 grams; 100 grams of orange peel and the percentage of adhesive used were 10%, 20%, and 30%.

This study uses a press, a sieve, a 1.5 dim pipe mold with a height of 3 cm, drums, burlap sacks, winnowing, collisions, simple combustion furnaces, and containers. Then the materials used are hot water, bagasse, orange peel, clay, tapioca flour, and banana midrib.

The research procedure in the manufacture of bio briquettes includes 4 stages, namely the preparation of raw materials, the carbonization process, the molding process, and the analysis test. The first stage is the preparation of raw materials. In this stage, the initial step is to cut the bagasse and orange peel into smaller sizes, then dry in the sun for 3 days.

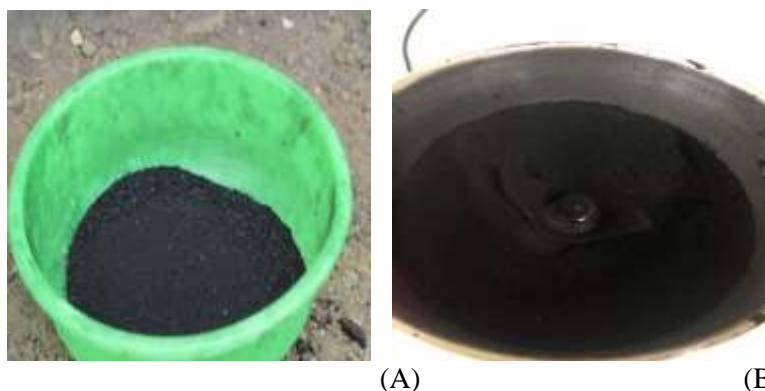


**Figure 1. Dried sugarcane bagasse and orange peel**

The second stage is the carbonization process which lasts for 4 hours. In this stage, first of all, put 1 kg of bagasse and 1 kg of dried orange peel into the drum (the carbonization process is carried out separately, then cover the drum with banana stems, burlap sacks, and add wet clay. Do the carbonization process for 4 hours. After the carbonization process is complete, remove the raw materials that have become carbonized. Then mash separately, until completely smooth.



**Figure 2. (A) Carbonization Process (B) Bagasse after carbonization**



**Figure 3. (A) Orange peel after mashing (B) Sugarcane bagasse after grinding**

The third stage is the printing process. First, weigh the bagasse and orange peel according to the specified variables. Then, weigh the tapioca flour as much as 10%, 20%, 30% of the total mass, then mix the tapioca flour with 50 mL of hot water. After that, mix the bagasse and orange peel that has been weighed with tapioca flour, stir until evenly distributed. Put it into the mold, then forged with a press. After that, dry using the sun for 3 days.



**Figure 4. Biobriquettes after printing**

The last stage is the analysis test. Namely, there is a heat test, water content test, briquette flame length test, and ash content test. The calorific value can be obtained and known by burning the prepared variable briquettes, then testing using a bomb calorimeter. Then the flame test was carried out by pouring a little kerosene into the briquette sample, then igniting. The initial length of time was observed until the briquettes completely turned to ash. The moisture content test was carried out by weighing the briquettes before being in the oven, then placing the briquette samples into a porcelain dish, then in the oven for 24 hours at a temperature of 105 °C. Then cool for 10 minutes, then weigh the briquettes.

$$\text{Water Content} = \frac{\text{Residual mass of ash (g)}}{\text{Dry mass of briquettes}} \times 100\%$$

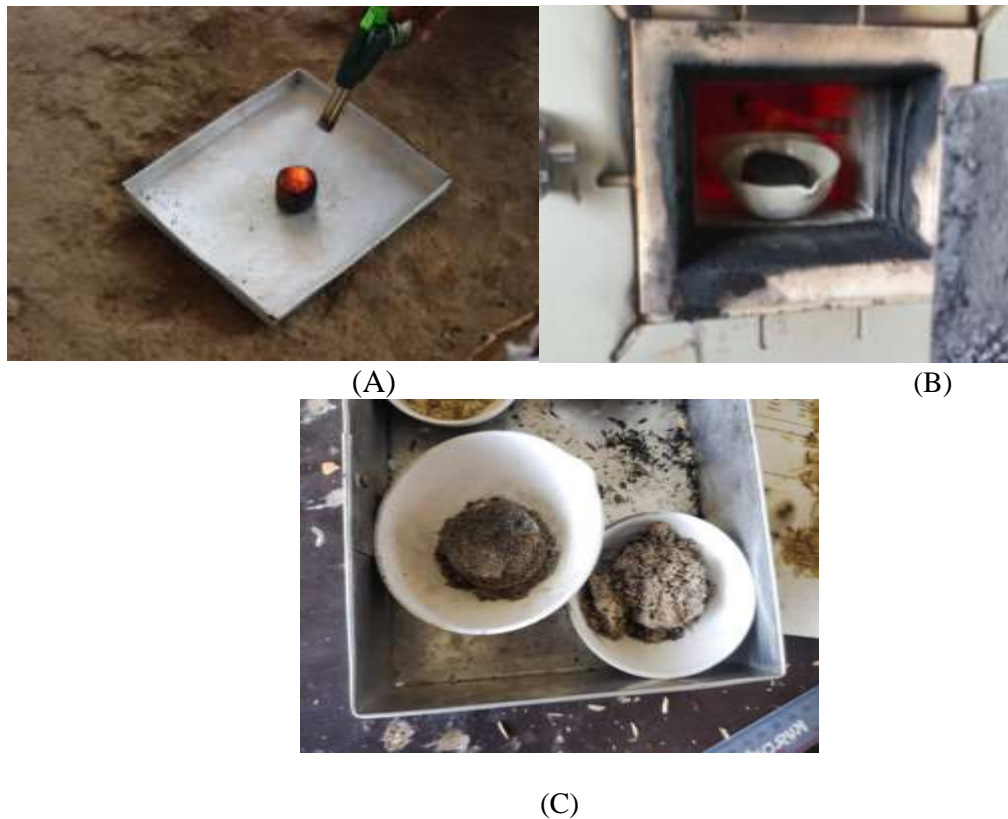


Figure 5. (A) Briquette flame test (B) Ash content test using a furnace (C)

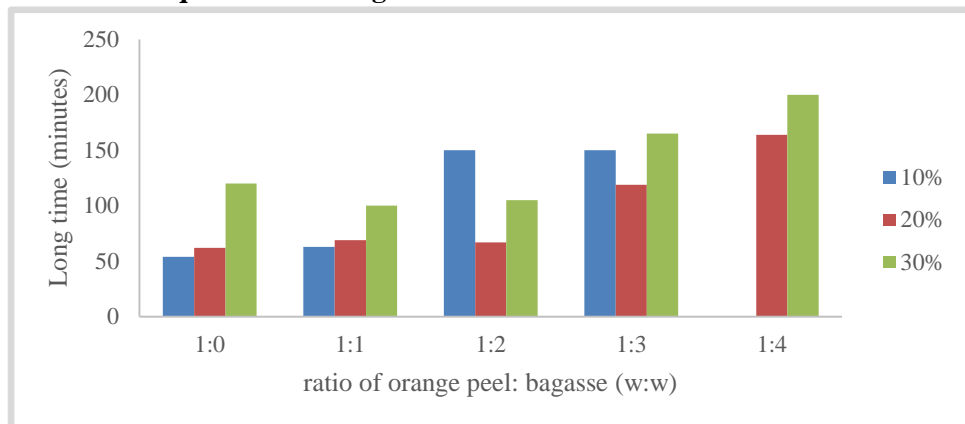
**Biobriquettes that have become ash**

The ash content test in briquettes can be determined by placing a porcelain cup in an oven at 105 °C for 1 hour. Then weigh the briquettes before being put into the furnace. Then, put the briquettes along with the porcelain cup into the furnace for 3 hours at a temperature of 700 °C. Then cooled for 15 minutes

$$\text{Water Content} = \frac{\text{Residual mass of ash (g)}}{\text{Dry mass of briquettes}} \times 100\%$$

**RESULT AND DISCUSSION**

**Determination of briquette flame length**

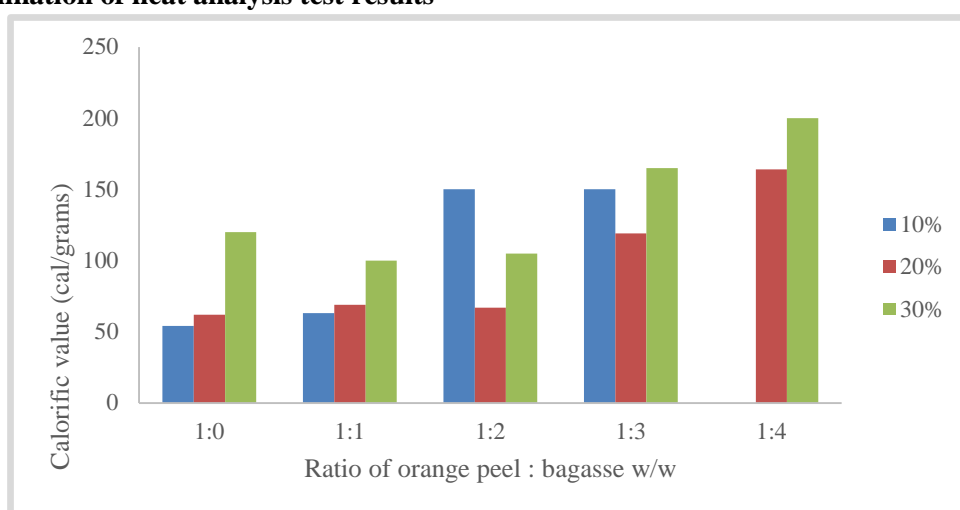


Graph 1. long briquette flame



Determination of the briquette flame duration test was carried out by pouring about 1 mL of kerosene into the briquette sample. After that, observe the initial time until the briquettes completely turn to ash. When this test took place, even though the briquettes were smoldering, they did not produce smoke. By following per under with the characteristics of good quality briquettes, which causes a little smoke. In this study, from 18 samples of the longest flame duration test, the adhesive variable was 30%, the mass of bagasse was 50 grams, and the mass of orange peel was 150 grams. While the longest flame test time was the fastest on the variable sample of 10% adhesive and 100-gram bagasse. The length of the flame is influenced by the structure of the material and the carbon content. It can be seen from the graph above that the largest carbon content is in the material which contains more bagasse than orange peel.

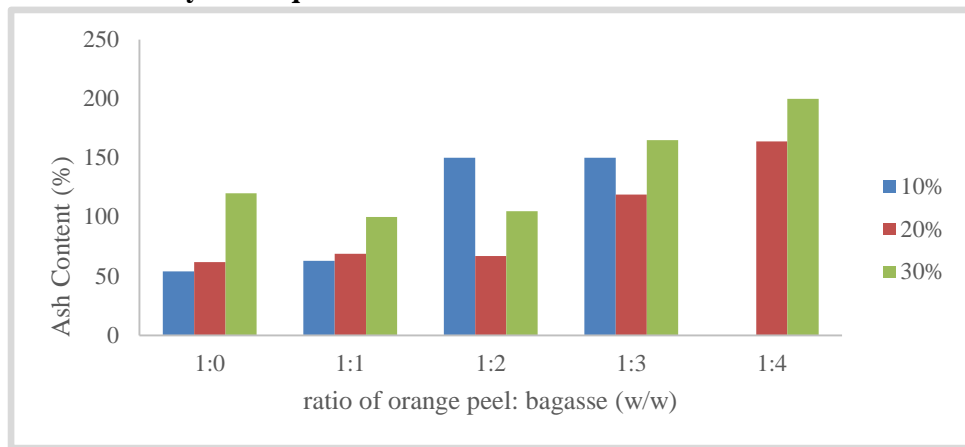
#### Determination of heat analysis test results



Graph 2 Calorific Value

The calorific value analysis test was obtained by burning 5 grams of briquette samples, using a bomb calorimeter. The calorific value is tested to see quality parameters that are known to be the maximum amount of heat energy released by a fuel. Of the 18 samples of calorific value that meet SNI, namely calorific value >5000, 3 samples that meet SNI. Namely the adhesive variable 20% 1:2, 20% 1:3, 20% 1:4. The highest calorific value in the variable 20% adhesive 1:2 is 5,949.114 cal/gram, while the lowest calorific value is in the variable 30% 1:3 at 3037.626. Referred to in graph 4.1. Regarding the analytical test results, it is by following per under the bio briquette theory. There should be less amount of adhesive the higher the calorific value should be. However, several aspects that can affect the small calorific value, namely the high water content, the long heating conditions of the water which can affect the water temperature causing the water to be mixed with a non-uniform temperature, high ash content so that the silica content is higher and therefore can affect -the calorific value. , and the amount of total mass of adhesive that can affect the calorific value.

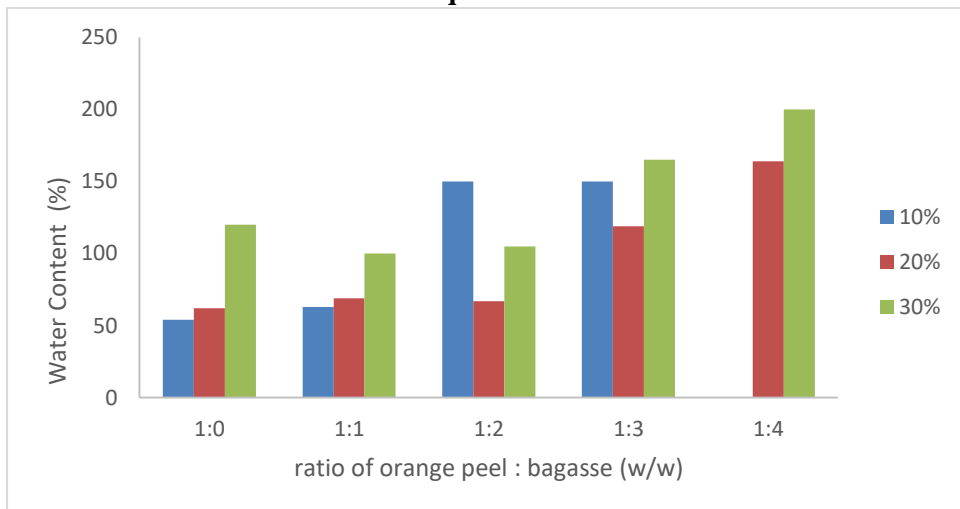
**Determination of assay on briquettes**



**Graph 3. Ash Content**

Briquettes produce a residue that is usually called ash, the ash produced by briquettes is produced from clay; sand; silica, and other minerals. The higher the ash content, the worse the quality of the briquettes, because it can produce a crust on the briquettes. The silica component contained in the ash content can affect the calorific value, based on SNI, a good ash content value is <8%. Of the 18 samples, the results of the ash content according to SNI were 9 samples. At 10% adhesive variable 1:1, 1:2, 1:3, 1:4, and 100 grams of bagasse only and at 30% adhesive variable 1:1, 1:2, 1:3, 1:4.

**Determination of water content test on briquettes**



**Graph 4. Water Content**

Analysis of the determination of the water content test can be known using utilizing employing oven briquettes for 24 hours at a temperature of 105 °C. The value of water content can affect the calorific value of the briquettes, based on SNI a good water content value is <8%. Of the 18 samples, only 1 sample was close to SNI, namely the adhesive variable 20% 1:1, amounting to 9%. Several aspects that the value of the moisture content, namely the pressure from different molding processes due to manual pressure, so the pores in the briquettes are not perfectly glued.

## CONCLUSION

Based on the research that has been done, it can be concluded as follows: The calorific value according to SNI 01-6235-2000 which is >5000 cal/gram is found in the adhesive variable 20% 1:2 at 5,949,114 cal/gram, adhesive 20% 1:3 at 5,706.348 cal/gram, and the adhesive variable 20% 1:4 for 5,026,064 cal/gram. Based on SNI a good ash content value is <8%. Of the 18 variables, the results of the ash content according to SNI are 9 variables. At 10% adhesive variable 1:1, 1:2, 1:3, 1:4, and 100 grams of bagasse only and at 30% adhesive variable 1:1, 1:2, 1:3, 1:4. Based on SNI, a good water content value is <8%. Of the 18 samples, only 1 sample was close to SNI, namely the adhesive variable 20% 1:1, amounting to 9%. The best variable is the 20% adhesive ratio 1:2 with a heating value of 5,949,114 cal/gram, 9% moisture content, 9% ash content, with a flame duration of 01.07.32.

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