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Energy Analyses of Biomaterial from Waste of Cassava Husk

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ABSTRACT

Starting from the zero-waste concept, where Indonesian cassava production is quite large, we can carry out the process of producing high-calorie bioenergy from cassava husks. The process is not only simple but also very convenient. In general, the approach used in this research is experimental. In this study, the main raw material used was cassava husks, which was dried in the sun before being crushed. The crushed cassava husks is then granulated. After receiving the granules, the briquettes are made. The cassava husks are soaked for three days and then mixed with water and the starch mixture removed. Cassava starch hide pulp is then treated with a series of alpha-emylase enzymes. The next step is the cooling process from a temperature of 105 degrees Celsius to 60 degrees Celsius, then poured into a glass jar with the addition of the enzyme amyloglucosidase. This research succeeded in converting cassava peel waste into bioenergy. From the test results, it can be seen that the liquid composition of cassava peel contains 4677.21 mg/1000 g fructose, 24.62 mg/1000 g glucose, 0.11 mg/1000 g maltose. From the tests conducted, it was found that the average calorific value of cassava husk briquettes increased by 45 percent compared to the calorific value of the raw materials, with the calorific value being 35,648.53 kJ/kg at a density of 0.544 kg/m^3.

INTRODUCTION

Cassava of any kind requires fertile and loose soil. Cassava elephants have the advantage that the tuber size is very large. With intensive treatment, the tuber weight of one trunk of cassava can reach 80 kg. With intensive cultivation, yields of about 150-200 tons per hectare are obtained, but on average 100 tons per hectare are reached. Cassava elephants also have different characteristics from other cassava, such as: the inside of the tuber skin is red, young stems are purple, dark brown stems and young leaves are brown. Cassava Elephant (Manihot esculenta) is a variety of cassava native to East Kalimantan that can produce up to 40 kg per tree. Cassava elephants can grow well in the lowlands and highlands, but not in swampy areas or in a constant, often flooded, water. With normal growth, the elephant cassava tree can reach a height of 4 to 5 meters. The average production of fresh cassava elephants of this species per hectare is 120 tons, the harvest is already 10 months old.

When harvesting cassava it depends on the harvesting techniques and in this case how the success lifts these tubers out of the ground. In the soil is clay or hard usually try to grab the bulb, so much is left in the ground because it is broken and even if it is deprived of matter in a state of decay. Therefore, harvesting techniques of cassava tubers need to be studied. For plants located on the plot, the harvesting process becomes easier because the tubers produced are mainly on the surface of the mainland, and the bumps are relatively loose. When the crop becomes dry or hard land, the soil is tilled by watering the soil plant water pump and leaving 1 (one) night to the ends of the tubers/roots. The demand for Indonesian cassava from abroad keeps increasing every year. Cassava can be processed into 16 economically valuable derivatives and has now become a world commodity that is always in demand by the market. China consumes two to three thousand tons of fresh cassava annually, as does South Korea, which needs semi-finished products and cassava waste. Domestic demand brought well-known brands to supply their stores with different products. Demand for cassava follows the amount of waste produced that can be used for high-calorie bioenergy.

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MATERIALS AND METHODS

Equipment and Materials

The equipment used in this study were drying machine, chopper machine, blender machine, glass jar, cooler, thermometer, bleaching machine, boiler, evaporator, spinner, briquette machine and bomb calorimeter. The materials used were cassava peels, alpha-emylase enzymes, amyloglucosidase enzyme and charcoal.

Making Cassava Peels

Preparation or procurement energy alternative achieved through making and development ingredient burn briquettes based on cassava waste. Plant of cassava capable produce biomass not less than 15 tons per hectare after harvest time, so that with thereby potential as source energy. For each kilogram in bars, waste of cassava has calorific value of 10,250 kJ, and the value is could increase along with decrease rate water and sugar. Waste of cassava is the potential energy biomass as the rest of the process production which not yet optimal could utilized. This is because the parties of craftsman not yet capable to utilize and processing it, because of the absence of knowledge and ownership technology applicable among them.

Development of briquettes from waste of cassava as a product of new industrial is an opportunity for add type product which generated have synergy with technology and marketing line existing product, horizontal diversification, efforts to increase product which no have connection with line product has there, and conglomerate diversification where the efforts to add new products to sell on group buyer, or take advantage of environmental opportunities that profitable although product new the no in a line with technology nor market which there is. Figure 1 indicates picture of Cassava elephant and its peel.



a. Cassava elephant tubers b. Cassava peel waste

Figure 1. Cassava elephant tubers and its peel waste

Processing Granulate of Cassava Peels

Starting from the zero waste concept, where Indonesia's cassava production is quite large, we can carry out the process of making high-calorie bioenergy from cassava peels. Not only the process is simple, but it's also quite practical. In general, the approach used in this research is experimental. In this study, the main raw material used was cassava peel which was dried in the sun before being chopped. The cassava peel that has been chopped is then granulated, as seen in Figure 2. After obtaining the granules, the briquettes are made. The cassava peels are soaked for three days and then blended with water and the starch mixture is taken. Cassava starch skin pulp is then added with a number of alpha-emylase enzymes. The next stage is the cooling process from a temperature of 105 degrees Celsius to 60 degrees Celsius, then put into a glass jar with the addition of the enzyme amyloglucosidase.

After going through the process of saccharification then goes into the process of bleaching with activated charcoal. To change from liquid into crystal, evaporation process is carried out to reduce the juice into a syrup by boiling off the water using steam (steam). Sometimes the syrup is cleaned up again but more often it just goes to the crystal-making step without any more cleaning. Evaporation in compound (multiple effect evaporator), which is heated with steam is the best way to get closer to saturation conditions (saturation).

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Figure 2. Cassava elephant peel waste after chopping with coarse and fine mash

Processing of Crystallization

The next stage is boiling (crystallization). In the final stages of processing, the syrup is placed into a very large container to boil. Inside this container of water evaporated so that conditions for sugar crystals to grow. Crystal formation is initiated by throwing some crystals, as seen in Figure 3.



Figure 3. Cassava elephant peel waste before treated and after treated

Once crystals are formed, the resulting mixture of crystals is spun in centrifuges to separate the two, rather like washing is spin dried. The crystals are then dried with hot air before being stored. The solution can be done by centrifugation still contains valuable sugar so the crystallization is repeated several times. After obtained details dregs cassava conducts manufacture the briquettes. In making briquettes conducted with apply composition comparison mix with three variation mixture with concentration adhesive start from 10%, 20%, and 30%.

Testing Calorific Value

The result of the mixing process these basic materials will be entered into the in print shaped cylinder with diameter of about 50 mm and tall 50 mm, then the compression is carried out after set all variable/parameter which needed.



a. Cassava Briquette b. Bomb calorie-meter

Figure 4. Bio briquette and bomb calorie-meter

Very urgent testing in this context is to determine the calorific value combustion (Calorific Value) using the "Bomb Calorimeter as shown in Figure 4 b.

The required characteristic is the value of heat tested using a bomb calorimeter according to the ASTM D-

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2015 test standard. In this experiment, calorific value testing of briquettes generated. Calorific Value (Calorific Value) can be calculated directly from bomb calorie meter by measure temperature difference between before and after bombing process, and the equation is:

$$Q = m * C_v * (T_2 - T_1) - m_{water} (h_{fg\ water}) \quad (1)$$

RESULTS AND DISCUSSIONS

After obtaining the granules, the briquettes are made. The cassava peels are soaked for three days and then blended with water and the starch mixture is taken. Cassava starch skin pulp is then added with a number of alpha-emylase enzymes. The next stage is the cooling process from a temperature of 105 degrees Celsius to 60 degrees Celsius, then put into a glass jar with the addition of the enzyme amyloglucosidase.

Composition of Cassava Peels

This research succeeded in utilizing cassava peel waste into bioenergy. From the test results, it can be seen that the liquid composition of cassava peels as described in Table 1.

Table 1. Composition of cassava peels

No.	Composition	Value (mg/1000 g)
1.	Fructose	0.1251
2.	Glucose	0.055
3.	Maltose	0.0987

Fermentation using trichoderma viride can increase the metabolic energy content of the original material. Enhancement metabolic energy content due to fermentation is a reflection of the presence of breakdown of crude fiber that is difficult to digest into easily digestible components.

This can be seen because of the role of the product cellulose enzyme of trichoederma viride which is able to degrade cellulose into glucose. The process of glucose metabolism will produce by-products in the form of carbon dioxide (CO) and H_2O carbon dioxide are produced from citric acid while water is produced by the process of the electron transport chain.

Through the process of energy metabolism then produced in the form of ATP and heat. Formation of ATP and heat. Heat is the core of the energy metabolism process, glycolysis process, acid cycle citrate and the electron transfer chain process. The cells in the body will be able to use and store the energy contained in the biomaterial for ATP energy.

In general, aerobic metabolic processes will be able to produce more energy than the anaerobic process. In the process of aerobic metabolism, 36 ATP will be formed while the anaerobic process will only produce 2 ATP. The bond that contained in the ATP molecule will be able to produce energy of 7.5 kcal/mole. This new concept increases the calorific value of material.

Physical Properties of Cassava Peels

From all cassava briquette prototypes, analyses are doing by physical and observation. Based on arrangement procedure, physical properties for each product are listed in Table 2.

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Table 2. Physical properties

No.	Material	Density (kg/m^3)	Water content (percent)
1.	Cassava peel (coarse mesh)	0.362	15.03
2.	Cassava peel (before treated)	0.375	14.51
3.	Cassava peel (after treated)	0.392	13.88
4.	Briquette of Cassava peel	0.544	10

From Table 2. it was found that physical value of briquettes from cassava peels increased by 45 percent from the density of the raw materials, where density was 0.544 kg/m^3 with water content reduce to 10 percent.

As is known that a lot of tapioca adhesive contains C atom in it, so the greater the concentration of adhesive, the score heat which generated also higher according with size of mesh with same size. One characteristics that must be owned by solid fuel other than grade of carbon. Calorific value characteristics are influenced by mass type (density), where the higher the density of the briquette, the higher calorific value can be produced. When compared to the value such as charcoal wood, it turns out that briquettes dregs cassava has score heat is higher.

Calorific Value

The drying process reduces the water content of the waste to the limit certain. This method is one of the processes physicists who are included in the surgery group separation. When heat is transferred from the heating medium to the material which is dried, the mass of water is transferred to drying medium. In other words, process heat transfer occurs and this given heat will raise the temperature of the material and causes the water vapour pressure inside the material is higher than at the water vapour pressure of the air. Calorific value described in Table 3.

Table 3. Calorific value

No.	Material	Calorific value (kJ/kg)
1.	Cassava peel (coarse mesh)	20,735
2.	Cassava peel (before treated)	24,585
3.	Cassava peel (after treated)	26,956
4.	Briquette of Cassava peel	35,649

The drying process reduces the water content of the waste to the limit certain. This method is one of the processes physicists who are included in the surgery group separation. When heat is transferred from the heating medium to the material which is dried, the mass of water is transferred to drying medium. In other words, process heat transfer occurs and this given heat will raise the temperature of the material and causes the water vapour pressure inside the material is higher than at the water vapour pressure of the air. When the air dryer penetrates wet material, partially the sensible heat of the drying air is converted to latent heat while

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generating water vapour. Before the drying process takes place, the vapour pressure of the water inside the material is within balance with the pressure of water vapour in the air surroundings. When this process occurs, the displacement mass of material into the air in the form of water vapour takes place or drying occurs on material surface. after that the vapour pressure surface water will decrease. After an increase in temperature occurs throughout the surface of the material, then the water movement occurs by diffusion from the material to the surface. Next is the evaporation process on the surface material will be repeated again. Finally, after water material is reduced, the water vapour pressure of the material will be decreases until equilibrium is reached with surrounding air. This process definitely increases the density of material and increase the calorific value of the material.

Drying and burning effectiveness determined by four things, such as: the velocity of vapour dispersion of the waste, the high temperature differentiation, i.e. the increase in the required temperature step, stirring, to speed up heat transfer, and the size. The smaller of the size means the surface becomes wider, and as a result, the water evaporates faster. This will also increase the calorific value of material.

Biodegradable materials are described mainly into carbon dioxide (CO_2) and water (H_2O). Heat is generated from microbial respiration by oxygen. The level of drying in addition to biological heat is by added aeration. The main part of the heat is biological, but naturally available through degradation aerobic organic matter, used for evaporates the surface and the water is bound to the mud mixture. This heat helps in reduce water content in biomass without need additional fossil fuels, and with minimal electricity consumption. This process reduces moisture content of the waste matrix by presence heat that causes water to evaporate into the phase air (steam), and produce dry products with the desired characteristics. The mechanism main drying is evaporation of moisture content by convection using heat from aerobic biodegradation of waste or matrix due to microbial activity in components matrix and is passed by an air flow that can set the speed. Moisture content in the waste matrix is reduced through two, the main step is that the water molecules evaporate from the surface of the waste fragments into the surrounding air, and then the evaporated water will drawn into the air stream and into the in exhaust gas. Water that seeps into the bottom of the matrix is collected in the bottom of the bio-drying reactor as leachate. The results of this processing produce dry waste products that have high calorific value.

CONCLUSIONS

This research succeeded in utilizing cassava peel waste into bioenergy. From the test results, it can be seen that the liquid composition of cassava peel contains 4677.21 mg/1000g of fructose, 24.62 mg/1000g glucose, 0.11 mg/1000g maltose. From the tests carried out, it was found that the average calorific value of briquettes from cassava peels increased by 45 percent from the calorific value of the raw materials, where the calorific value was 35,648.53 kJ/kg with a density of 0.544 kg/m^3.

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