VOL. 13, NO. 3, FEBRUARY 2018 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

INVESTIGATION ON BIOMASS BRIQUETTE FROM *Cerbera manghas* WASTE TWIGS AS RENEWABLEENERGY SOURCE

Willyanto Anggono[1,2], Fandi D. Suprianto[1,2], Sutrisno[1,2], Gabriel J. Gotama[1,2], Jovian Evander[1,2] and Andreas W. Kasrun[1,2]
[1]Centre for Sustainable Energy Studies, Petra Christian University, Surabaya, Indonesia
[2]Mechanical Engineering Department, Petra Christian University, Surabaya, Indonesia
E-Mail: willy@petra.ac.id

ABSTRACT

Indonesia is a tropical nation that has numerous assortments of plants. However, these resources have not been utilized perfectly as assets. One of the plants that are frequently seen in Indonesia is *Cerberamanghas*. *Cerberamanghas* is known as one of the trees that have strong roots and it is generally utilized for greening in Surabaya. Although used as shading trees and to decrease air contamination in urban regions, squanders from the twigs of this plant turn into a significant issue for the cleanliness of the city. To tackle this problem, the waste from the falling twigs can be utilized as briquettes when handled well. This study intended to research the capability of *Cerberamanghas* twigs wastes to be utilized as biomass briquettes and also to assess the properties of the briquettes. The proximate and ultimate analysis examinations were conducted to obtain the property of the briquettes. The influence of tapioca percentage in briquette to the calorific value of the biomass briquettes was also obtained in this study. Calorific values of five blends with different tapioca mixtures of 10%, 20%, 30%, 40%, and 50% were assessed by using oxygen bomb calorimeter. The outcomes of the study suggest that the biomass briquettes made of waste *Cerberamanghas* twigs can be made by utilizing tapioca as a binder. The more prominent the rate of the mass of tapioca in the briquettes, the lower calorific value obtained in briquette. Biomass briquettes made of waste *Cerberamanghas* twigs can be made into a source of manageable energy with the ideal mixtures of 90% *Cerberamanghas* waste twigs and 10% tapioca.

Keywords: *Cerberamanghas*, biomass, twig, briquette, sustainable energy.

1. INTRODUCTION

The shifting of energy source from non-renewable to renewable becomes eminent nowadays. While non-renewable fuels do exist in some great number, it will only take some years before it becomes scarce and even longer to recuperate from the energy crisis derived from its exploitation. This energy emergency happens due to the development in fuel utilization rate and populace components. Other than sparing this non-sustainable power sources, the look for new option energy is expected to satisfy the human needs.

Biomass is the most well-known type of sustainable power source and generally utilized as a part of the third world. The cases of biomass fuel are, for example, biodiesel, biogas, horticultural waste and so on. The resources of biomass can be created from farming products and build-ups, ranger service harvests and deposits, ocean weeds and green growth, creature deposits, modern build-ups, metropolitan strong waste and sewage [1]. Biomass is a viable option for solving energy crisis from its advancement for substitute of petroleum energy source. Biomass likewise ends up plainly famous these days. An analysis about bioenergy demonstrates that bioenergy has a potential as a viable energy source and the use of biomass additionally rise now and again [2-6].

Indonesia is one of the nation that has numerous assets of energy, for example, oil, and coal. Indonesia winds up noticeably as a high coal exporter in 2014. Moreover, Indonesia is one of agrarian nation which was displayed from the 70% from 186 million hectares is utilized to farming part [7]. This condition gives a chance to create biomass elective energy utilizing rural waste. Because of the Indonesian government become environmentally viable arrangements, each city in Indonesia ought to plant more trees to limit a worldwide temperature alteration and counter the emanation of vehicle.

Figure-1. City Park with *Cerberamanghas*, Surabaya, Indonesia.

Trees are the primary component in the city stop and they are valuable in enhancing the air quality in thickly populated urban areas, for example, City Park with *Cerberamanghas*, Surabaya, Indonesia as appeared in

ARPN Journal of Engineering and Applied Sciences

Figure-1. Then again, planting countless plants causes a great deal of waste twigs. Government and numerous groups in Surabaya are confronting difficult issue with the strong waste twigs (*Cerberamanghas*) transfer issue and extensive endeavours are being made to decrease the amounts of wastes.

These waste twigs of *Cerberamanghas* can be utilized as a viable energy source through the correct procedure. Beforehand, there was a trial with respect to biodiesel creation from *Cerberamanghas* and it demonstrates that *Cerberamanghas* has potential as energy source [8]. Biomass fuel can be delivered from waste item [9-12,13], for example, almond twigs, sawdust and coco peat, rice husk, sugar stick twigs and rice straw. Briquetting is one method to utilize the from biomass energy created from waste item. Substances found in *Cerberamanghas* twigs are, for example, p-hydroxybenzaldehyde, benzamine, n-hexadecane corrosive monoglyceride, loliolide, β-sitosterol, cerberin, neriifolin, cerleaside A, daucosterol.*Cerberamanghas* twigs contain some synthetic synthesis that might be harmful to living animal, for example, human and creature which guarantee us that *Cerberamanghas* is a non-edible plant [14]. The non-edibility of *Cerbera manghas* will ensure its utilization will not jeopardize the food stock available for human consumption. In utilizing *Cerbera manghas* as renewable fuel source, it is critical to explore the major properties of biomass briquettes made of waste *Cerberamanghas* twigs, such as, proximate and ultimate analyses, calorific value and the impact of tapioca percentage as a cover material for briquette.

2. EXPERIMENTAL METHOD

The waste materials used in this study are the fallen twigs of *Cerberamanghas*, because falling twigs indicate that they are old and begin to dry. Once collected, the twigs must be sun dried for three days. Biomass briquettes were made by crushing dried waste twigs of *Cerberamanghas* as shown in Figure-2, mixing them with tapioca flour as a binder material and compacting the mixture under pressure.

Figure-2. Crushed *Cerberamanghas* twigs.

The measurement of calorific value of the biomass briquette from waste twigs *Cerberamanghas* was conducted using a 1341 Plain Jacket oxygen bomb calorimeter Parr Instrument at various composition of *Pterocarpusindicus* leaves waste. Initially, 100% *Cerberamanghas* twigs and 100% tapioca as binder material have been measured. All experiments in this paper were performed with mixtures of various tapioca as a binder material from 10% (90% composition of *Cerberamanghas* twigs) to 50% (50% composition of *Cerberamanghas* twigs).

3. RESULTS AND DISCUSSIONS

Based on the experimental investigation using an oxygen bomb calorimeter, the calorific value of 100% *Cerberamanghas* twigs (dry basis)was 4790 Kcal/Kg and the calorific value of 100% tapioca as a binder material was 3574.47 Kcal/Kg. The calorific value of biomass briquette from waste twigs *Cerbera manghas* at various composition mixtures are shown in Table 1 and a summary of the results from calorific value of *Cerbera manghas*–tapioca mixtures at various composition are shown Figure-3.

Table-1. Calorific value of dry basis biomass briquette from waste twigs *Cerberamanghas*at various composition.

Biomass briquette composition	**Calorific value** (Kcal/Kg)
90% *Cerbera manghas* waste twigs and 10% tapioca mixtures	4628
80% *Cerbera manghas* waste twigs and20% tapioca mixtures	4393
70% *Cerbera manghas*waste twigs and 30% tapioca mixtures	4167
60% *Cerbera manghas* waste twigs and40% tapioca mixtures	3989
50% *Cerbera manghas* waste twigs and50% tapioca mixtures	3871

ARPN Journal of Engineering and Applied Sciences

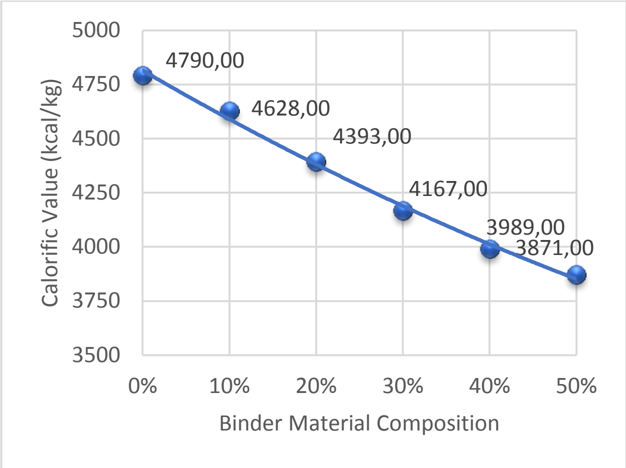

Figure-3. Effect of binder material to the calorific value of biomass briquette from waste twigs *Cerberamanghas* at various composition.

The higher is the percentage of tapioca in briquette, the lower the calorific value of the biomass briquette derived from *Cerberamanghas* twigs. The highest calorific value of the biomass briquette *Cerberamanghas* twigs was the biomass briquette obtained by utilizing 90% *Cerberamanghas* twigs-10% tapioca blends as appeared in Figure-3.The creation of *Cerberamanghas* and tapioca as cover material was done using piston mold as seen in Figure-4. The 90% *Cerberamanghas*-10% tapioca blends appearance is given in Figure-5. The molecule size of *Cerberamanghas* briquette is 60 Mesh. In the wake of squeezing procedure, the briquette must pass through drying process. This analysis utilizes room temperature to dry the briquette.

Figure-4. *Cerberamanghas* twigs briquette mold.

Figure-5. *Cerberamanghas* twigs briquette.

The reason 90% *Cerberamanghas* twigs-10% tapioca blends gives the best calorific value is because tapioca as a binder material decreases the calorific value of the biomass briquette. The more prominent measure of tapioca, the lower the calorific value of the biomass briquette from *Cerberamanghas* twigs. This phenomenon provides advantage in term of cost. The best briquette composition, 90% *Cerberamanghas* twigs-10% tapioca blendsrequires small cost to produce. This happened because of the fact that *Cerberamanghas* twig is available without cost and the tapioca as a fastener material needs to be purchased (the cost of tapioca in Indonesia around 0.5 USD/kg in September 2017). Thus, the higher the percentage of tapioca in the biomass briquette from waste twigs *Cerberamanghas* the higher the cost of the briquettes.

Table-2. Proximate analysis dry basis result of *Cerberamanghas* twigs briquettes.

Parameters	Unit	Value	Test method
Volatile Matter	%wt	76.9	ASTM D 3175-11
Ash Content	%wt	4.9	ASTM D 3174-12
Fixed Carbon	%wt	18.2	ASTM D 3172-13
Gross Calorific Value	Kcal/Kg	4628	ASTM D 5865-13

The proximate investigation has been inspected through a research centre test. The test utilizes some ASTM institutionalization. The volatile matter was analysed utilizing ASTM D3175-11. The ash content was analysed utilizing ASTM D3174-12. Fixed carbon count was analysed utilizing ASTM D 3172-13. The gross calorific value was analyzed utilizing ASTM D 3172-13. The proximate analysis dry basis result of *Cerberamanghas* twigs briquettes is shown in Table-2.

Table-3. Ultimate analysis result of *Cerberamanghas* twigs briquettes.

Parameters	Unit	Value	Test method
Carbon	%wt	20.81	ASTM D 5373-14
Hydrogen	%wt	2.67	ASTM D 5373-14
Nitrogen	%wt	0.25	ASTM D 5373-14
Sulphur	%wt	0.04	ASTM D 5373-14e1
Oxygen	%wt	14.75	ASTM D 5373-15

The ultimate analysis used to investigate the Carbon, Hydrogen, Oxygen, Nitrogen and Sulphur concentration on *Cerberamanghas* twigs briquettes. The examination of the ultimate analysis using ASTM D 5373-14, ASTM D 5373-14e1 and ASTM D 5373-15. The result of ultimate analysis of *Cerberamanghas* twigs briquettes is shown in Table-3.

Cerberamanghas twigs briquette has the highest calorific value compared to sawdust briquette, sugarcane briquette, rice straw briquette and coconut coir briquette. The calorific values of sawdust briquette, rice straw briquette, sugarcane briquette and coconut coir briquette are 4161.0898 kcal/kg, 3902.9637 kcal/kg, 3926.8642 kcal/kg and 4146 kcal/kg,respectively [12,15].

4. CONCLUSIONS

Biomass briquette from waste twigs *Cerberamanghas* is a renewable energy source and tapioca is a possible binder material on the biomass briquette derived *Cerberamanghas* waste twigs. This study discovered that the more prominent is the tapioca percentage as a binder material, the lesser the calorific value of the briquette and the higher the cost of producing biomass briquette from waste twigs *Cerberamanghas*. The biomass briquettes from waste twigs *Cerberamanghas* utilizing 90% waste twigs *Cerberamanghas* and 10% tapioca was found as the ideal proportion.

ACKNOWLEDGEMENTS

Many thanks to Petra Christian University Indonesia and Direktorat Jendral Pendidikan Tinggi Kementerian Riset Teknologi Dan Pendidikan Tinggi Republik Indonesia (Hibah Penelitian Produk Terapan 2016-2017) which have supported this research.

REFERENCES

[1] Baskar C., Baskar S. and Dhillon R.S. 2012. Biomass Conversion - The Interface of Biotechnology, Chemistry and Materials Science, Springer-Verlag, Berlin Heidelberg (Germany).

[2] Anggono W., Wardana I.N.G., Lawes M., Hughes K.J., Wahyudi S., Hamidi N. and Hayakawa A. 2013. Biogas Laminar Burning Velocity and Flammability Characteristics in Spark Ignited Premix Combustion. Journal of Physics Conference Series. 423: 1-7.

[3] Anggono W., Wardana I.N.G., Lawes M. and Hughes K.J. 2013. Effects of Inhibitors on Biogas Laminar Burning Velocity and Flammability Limits in Spark Ignited Premix Combustion. International Journal of Engineering and Technology.5(6): 4980-4987.

[4] Anggono W., Wardana I.N.G., Lawes M., Hughes K. J., Wahyudi S. and Hamidi N. 2012. Laminar Burning Characteristics of Biogas-Air Mixtures in Spark Ignited Premix Combustion. Journal of Applied Sciences Research.8(8): 4126-4132.

[5] Serrano C., Hernandez J. J., Mandilas C., Sheppard C.G.W. and Woolley R. 2008. Laminar Burning Behaviour of Biomass Gasification-Derived Producer Gas. International Journal of Hydrogen Energy. 33: 851-862.

[6] Rosua J.M. and Pasadas M. 2012. Biomass Potential in Andalusia, from Grapevines, Olives, Fruit Trees and Poplar, for Providing Heating in Homes. Renewable and Sustainable Energy Reviews. 16(6): 4190-4195.

[7] Widiarta A., Rosyida I., Gandi R. and Muswar H.S. 2009. Peasant Empowerment through Social Capital Reinforcement: Road to Sustainable Organic Agriculture Development. Asian Journal of Food and Agro-Industry,(Special Issue): 297-306.

[8] Ong H.C., Silitonga A.S., Mahlia T.M.I., Masjuki H.H. and Chong W.T. 2014. Investigation of Biodiesel Production from *Cerbera manghas* Biofuel Sources, Energy Procedia. 61: 436-439.

[9] Raju C.A.I., Jyothi K.R., Satya M. and Praveena U. 2014. Studies on Development of Fuel Briquettes for Household and Industrial Purpose. International Journalof Research in Engineering and Technology. 3(2): 54-63.

[10] Prasityousil J. and Muenjina A. 2013. Properties of Solid Fuel Briquettes Produced from Rejected Material of Municipal Waste Composting. Procedia Environmental Sciences. 17: 603-610.

[11] Yank A., Ngadi M. and Kok R. 2016. Physical Properties of Rice Husk and Bran Briquettes under Low Pressure Densification for Rural Applications. Biomass and Bioenergy. 84: 22-30.

ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

[12] Jittabut P. 2015. Physical and Thermal Properties of Briquette Fuels from Rice Straw and Sugarcane Leaves by Mixing Molasses, Energy Procedia. 79: 2-9.

[13] Sutrisno Anggono W., Suprianto F.D., Kasrun A.W., Siahaan I.A. The Effects of Particle Size and Pressure on the Combustion Characteristics of *Cerbera manghas* Leaf Briquettes. ARPN Journal of Engineering and Applied Sciences. 12: 1-6.

[14] Zhang X.P., Pei Y.H., Liu M.S., Kang S.L. and Zhang J.Q. 2010. Chemical Constituents from the Leaves of *Cerbera manghas*. Asian Pacific Journal of Tropical Medicine. 3: 109-111.

[15] Lela B., Barišić M. and Nižetić S. 2016. Cardboard/Sawdust Briquettes as Biomass Fuel: Physical-Mechanical and Thermal Characteristics, Waste Management. 47(Part B): 236-245.